MATRIX TEST EQUIPMENT INCORPORATED

MODELS ASX-16 AR-12

INSTRUCTION MANUAL

MULTIPLE FREQUENCY SIGNAL GENERATOR
MODEL ASX-16

SIGNAL STRENGTH AND DISTORTION ANALYZER
MODEL AR-12

ASX-16
S/N 152

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SECTION I

THEORY OF OPERATION AND REPAIR

1-1. Introduction

The Matrix Test Equipment Inc. Model ASX-16 and Model AR-12 are often used together. For this reason, this manual will contain the information pertinent to both devices. Of course, the devices can be used separately, since there are no signal interconnections between the two units.

Section II of this manual describes the equipment and their operations in more detail.

1-2. Theory of Operation

When the two units are used together, the Model ASX-16 is considered the "Generator" portion of the system and the Model AR-12 is considered the "Receiver" portion of the system. The names "Generator" and "Receiver" are used in the descriptions, below.

Note that the following Figures have been intentionally omitted from this manual: Figures 1-1, 1-2, 1-8, and 1-18.

1-2.1 The Generator Controller Hardware

The Generator Controller is illustrated in Figure 1-3. Based on a 6502 Central Processing Unit (CPU), the Generator Controller produces a sixteen-line Address Bus (A0 through A15) and an eight-line Data Bus (D0 through D7). In addition, the CPU generates a clock (Ø2) and Read/Write signal (R/W). These signals are used by the other integrated circuits (IC's) in Figure 1-3.

The CPU can be reset by two methods. The first method is activated by removing power from the Generator (in other words, by turning it off). This causes the 1 microfarad capacitor on pins 5 and 6 of IC 10 (4093) to discharge. When the power is returned, the capacitor will charge up slowly. Until it charges up to approximately 3 volts, the 2N3904 transistor on pin 40 of the CPU will be saturated, pulling the RESET line low. Once the capacitor has charged up, the transistor will cut-off, allowing the 4.7K resistor on pin 40 of the CPU to pull the RESET line high. The second method for resetting the CPU is via the MANUAL RESET input. This input comes from the front-panel-mounted RESET switch. Pressing this switch, rapidly discharges the 1 microfarad capacitor, causing the transistor on pin 40 to saturate until the capacitor is allowed to recharge.

The remaining three gates of IC 10 (4093) make up the Generator Controller's CPU clock. One gate of IC 10 acts as a simple RC oscillator; the other two act as buffers. IC 10 oscillates very readily because it is a Schmitt trigger gate. This also makes the power-up reset (described above) function more cleanly.

The READY, IRQ, and NMI external lines are not used, although the IRQ line does go to other IC's on the Generator Controller board.

IC 2 and IC 3 contain both Random-Access Memory (RAM) and Input/Output (I/O). Note that a DIP switch connected to IC 2. This switch is set to the Generator Controller's IEEE 488 bus address before the unit is powered up (if the address is changed after the Generator is turned on, it will be necessary to RESET the unit so that the CPU will be able to read the address change).

IC 9 and IC 13 are buffers which provide the Generator Controller with the ability to drive a greater number of IC's.

Note that IC 2's outputs are broken into two fields: LS0 through LS3 (which are buffered) and LS4 through LS7 (which are unbuffered). LS4 through LS7 are brought to IC 11 (a 4-to-16 line converter). IC 11 decodes LS4 through LS7 into fifteen Bank Select lines which are then used throughout the Generator along with the (buffered) LS0 through LS3 lines.

IC 3 produces eight data lines (D0 through D7) the lower five of which go to the latch boards and which are used by the rest of the Generator. These are not the same D0 through D7 as on the CPU's Data Bus. The CPU's Data Bus is used exclusively on the Generator Controller board, and does not have connections off the board. The data to the latch boards goes off the Controller board and has no other connections on the Controller board. Note the D0 through D4 are buffered by IC 13.

The Generator Controller is programmed (by Matrix) using three Read-Only Memories (ROM's) -- it is not easily reprogrammable by the user. These three ROM's are IC's 4A, 4B and 4C, each of which contains 512 bytes of instructions and data.

The final portion of the Generator Controller is the IEEE Interface section, made up of IC's 5, 6, and 12. IC 5 is a TMS9914. This is a special-purpose microprocessor which handles all the protocol and interfacing to the IEEE 488 bus. IC's 6 and 12 are buffers which isolate the Generator Controller from the rest of the IEEE 488 bus.

1-2.2 The Generator Controller Operation

On power-up (or reset), the Generator Controller sets certain portions of the Generator to known, protected states. When the unit is first turned on, the -28 volt DC supply to the Generator modules is turned off. This is done to protect any external equipment (such as a power meter sensor) from a sudden surge of RF power that might occur on turn-on. Once the Generator Controller has set up the RF attenuator and the Generator modules, the -28 volt supply is powered up. If the Generator Controller is reset manually (without turning the power off, the -28 volt supply is unaffected by the reset.

Whenever the Controller is reset, the RF attenuators are set to their maximum value and each of the Generator modules is set to their mid-point (step 128) power level. See Section 1-2.4 and the "L" command in Section 2-3 for a more thorough explanation.

In operation, the Generator Controller receives commands via the IEEE 488 bus and responds by changing the configuration of the Generator and/or by transmitting information back to the IEEE 488 bus.

As described in Section 2-3, there are two types of commands to which the Generator Controller will respond: slave and handshake. As mentioned in Section 2-3, the handshake commands can cause the IEEE 488 bus to be tied up if the handshake is not properly completed. It is important to remember that all handshake commands must be completed as outlined in Section 2-3-- if this is not done, the Generator will appear to have failed. The only "fixes" possible are to either complete the handshake, reset the Generator Controller, or turn the Generator off, then back on.

1-2.3 Generator Controller Wiring

Figure 1-4 indicates what each line coming off the Generator Controller is used for. The Bank select lines are used to select that portion of the Generator to which the LS0 through LS3 and the D0 through D4 signals will be "routed". Note the details called out on the D0 through D4 lines in Figure 1-4. A signal with a bar over it indicates inversion or an active-low condition. For example, D0 will be high to turn an RF Generator Module ON and low to turn a Module OFF.

It is important to note that the signals shown are not steady-state. Since the same D0 through D4 lines are used to address all parts of the Generator the signals on these lines

may switch from state to state as different portions of the Generator are controlled. In general, the signals will look like a momentary pulse.

1-2.4 Generator Module Driver

The RF Generator Modules are arranged in banks of 16. Each bank is driven by a pair of identical Module Driver boards. Figure 1-5A illustrates the schematic of the only non-duplicated portion of a Module Driver board. The Bank Select Plug can be inserted two different ways. The way the plug is inserted will determine whether the board will be used to drive odd-numbered modules or even-numbered ones. The two boards alternately drive the modules (for example, if the top board drives the end modules, the bottom board will drive the next-to-the-end modules, etc.). The circuitry in Figure 1-5A produces the CE (Chip Enable) and inverted CE signals needed by the circuitry in Figure 1-5B.

There are eight identical sections on each of the two Module Driver boards -- each section can drive one module. The schematic for one of these sections is illustrated in Figure 1-5B.

In Figure 1-5B, the ON/OFF, MOD/CW, and -35dB/NORMAL signals are latched by the 3-bit inverting latch (at the top of the page) whenever the appropriate CE signal is produced by the circuitry from Figure 1-5A. The three latched signals are fed directly to the Generator Module (see Section 1-2.5 for more information on how these signals are used).

The remaining circuitry in the section is used to control the output level of the RF Generator Module. The two 4516 (4-bit counters) IC's make up an 8-bit binary counter which can be made to count up or down depending on the level of the signal applied to their UP/DOWN input. On power-up (or reset), the 8-bit counter is preset to 128 (this represents the mid point in the 0 to 255 range of the counters). By controlling the UP/DOWN line and by pulsing the CLOCK line, the counters can be made to count up or down by the number of clock pulses generated. The digital (binary) output from the 8-bit counter is fed to the 1408 which is a Digital-to-Analog converter (D-to-A). The 3140 op-amp converts the current-output of the D-to-A into a voltage-output. As the count in the 8-bit counter is raised or lowered, the output voltage on pin 6 of the op-amp changes proportionately. This voltage is fed to the RF Generator Module to control its output level.

1-2.5 RF Generator Modules

Figure 1-6 illustrates the circuitry inside a typical Generator Module. Certain components have been left unspecified because these values are determined by the frequency of operation and are different for each Module.

In addition to the variable capacitors (used for tuning and peaking the RF stages), there are four independent electronic controls to the Module and one manual adjustment to it. The Module can be set, using the MONULATION CONTROL (CW/MOD), to operate either CW or 100% modulated at 15.75 KHz.

Three different mechanisms are used to insure, in CW operation, that any residual modulation will be attenuated at least 110 dB down. When the Module is set for CW, a 2N3904 transistor is saturated, tying -28 volts to the anode end of a diode. This back-biases the diode, preventing the 15.75 KHz signal from getting through and also shunts any residual modulation to the heavily-bypassed-to-ground -28 volt line. In addition, a 2N3906 transistor is saturated, shorting any residual modulation (getting through the .1 microfarad capacitor) to ground. When the Module is set for 100% modulated operation, the above diode is forward-biased and the above two transistors are cut-off.

The RATIO CONTROL (-35 dB/NORMAL) uses the same circuitry as in the 100% modulation mode. In NORMAL, this control line has no effect on the Module output, but in the -35 dB mode, the RATIO CONTROL brings the carrier level down to the same depth (minimum level) as if it were fully downward-modulated (of course, as long as the -35 dB/NORMAL line is held low, the carrier remains down, regardless of the state of the modulation control).

The ON/OFF control line functions by controlling a 2N4923 pass-transistor which connects the -28 volt DC power to the RF oscillators and amplifiers.

The AGC control line functions by controlling the DC voltage applied to the output stage of the Generator Module. Since this stage is a class C amplifier, its output power is controlled by the amplitude of its DC power source. The AGC voltage input varies over 0 to -10 volt range.

The only manual adjustment is the 500 Ohm rheostat feeding the RF filter (in the lower right-hand corner of the schematic). This adjustment is used to equalize all Generator Module outputs when they are on step 128 (the middle step).

1-2.6 The Relay/Attenuator Driver Board

Figure 1-7 illustrates the Attenuator Driver board. Each of the 4401's is a 4-bit inverting latch. These latches receive and hold the attenuation data sent by the Generator Controller. The outputs of these latches are buffered by an array of 2N4923 transistors.

The 74LS138 is a 3-to-8 line converter which is used as an address decoder. It is enabled whenever the BANK 14 select line is enabled (brought low). Upon enabling, the address (determined by the states of latch select lines LS0, LS1, LS2) of the latch is decoded. The decoded output from the 74LS138 is fed to the latch enable line of the appropriate latch.

Also on this board is the POWER RELAY flip/flop which activates the -28 volt power supply as described in Section 1-2.2 (above). The flip/flop is set by the BANK 13 select line and cleared (when the unit is first powered up) by the RC on pin 1 of the flip/flop.

1-2.7 Modulation Generator

The schematic of the Modulation Generator board is illustrated in Figure 1-9. This board contains a crystal oscillator whose frequency is divided down digitally to 15.75 KHz. Two heavily-buffered outputs are available from the Modulation Generator. These outputs have enough drive capability to drive more than thirty RF Generator Modules each. Approximately half the Generator Modules are driven from each output.

1-2.8 Receiver Controller Hardware

The schematic of the Receiver Controller is illustrated in Figure 1-10. It is virtually identical to the hardware described in Section 1-2.1 (above). Rather than repeat this information, this Section will cover the differences between the Generator Controller and the Receiver Controller.

The primary differences between the two Controller boards lie in their Input/Output capabilities. Unlike the Generator Controller, the Receiver Controller is not required to drive a great number of other circuits. For this reason, the Receiver Controller does not need the buffering found in the Generator Controller. IC's 2 and 3 on the Receiver Controller board connect directly with the rest of the Receiver.

The DIP switch connected to IC 2 is used to set the IEEE 488 bus address for the Receiver Controller. IC 2 also produces eight LATCH SELECT LINES (LS0 through LS7) of which only LS0, LS1, and LS2 are used in the Receiver. IC 2 inputs the AGC HIGH and AGC LOW lines from the RF-Box-mounted AGC Comparitor board of Figure 1-14C.

IC 3 receives the feedback signals from the Composite Triple Beat board and from the Commutative Filter board (see Figures 1-17 and 1-16, respectively). These signals allow the processor to adjust its Audio (distortion) Attenuator until the proper operating level is reached. This topic is covered in more detail in Section 1-2.9. IC 3 outputs DATA lines D0 through D7 which are used off the board. These data lines are not to be confused with the D0 through D7 of the CPU's Address Bus (which are used exclusively on the Controller board and which do not go off the board).

The Receiver Controller uses a less complicated program than the Generator Controller. For this reason, its program is contained in only two ROM's, IC 4B and IC 4C.

1-2.9 Receiver Controller Operation

On power-up (or reset), the Receiver Controller sets the RF Attenuator to a high value to protect the Receiver from possible overload. It also de-selects the bank of RF filters (none of the filters are selected). Finally, the Receiver Controller sets the SECOND/THIRD/XMOD and COMPOSITE TRIPLE BEAT Zeros to 0.0 dB.

As described in Section 2-3 and 2-4, the Receiver Controller responds to two types of commands: slave and handshake. As mentioned in these Sections, the handshake commands can cause the IEEE 488 bus to be "tied up" if the handshake is not properly completed. An incomplete handshake will make the Receiver look as if it has failed. The only "fixes" possible are to either complete the handshake, reset the Receiver Controller, or to turn the Receiver off, then back on.

When a distortion measurement is made, the Receiver Controller first checks the AGC HIGH and AGC LOW lines, to determine whether the RF input signal is within the AGC "window". If the signal is outside the allowable range, the Receiver Controller alters the value of the RF Attenuator, if possible, to put the signal within the AGC "window". Once the proper operating level has been adjusted, the Controller sets the Audio (distortion) Attenuator to 64 dB. The Controller then checks the appropriate feedback signals (either from the Composite Triple Beat Processor or the Commutative Filter Processor) to determine in which direction to move the audio attenuator (more attenuation, less, or

leave it alone). In turn, the 64, 32, 16, 8, 4, 2, 1 and .5 dB audio attenuators are adjusted until the appropriate Processor board indicates that the Audio Attenuator is set to the correct value.

It is important to note that the Receiver Controller only looks at the AGC comparitors (and therefore, only changes the RF Attenuator) at the start of a distortion reading. Should the RF signal level change in the middle of, of after, a distortion reading, the Receiver Controller will ignore the change.

1-2.10 Receiver Controller Wiring

Figure 1-11 indicates what each line coming off the Receiver Controller is used for. Do through D7 are used to transfer the data to the Distortion Attenuator, the RF Attenuator, and to the Filter Selector board(s). LS0 through LS2 are used to select which Receiver section the data is intended for.

It is important to note that the signals shown are not steady-state. Since the same Data lines are used to transfer data to the entire Receiver, the signals on these lines may switch from state to state as different portions of the Receiver are controlled. In general, the signals will look like momentary pulses.

1-2.11 Receiver Filter Selector

The schematic for the Receiver Filter Selector boards is illustrated in Figure 1-12. For units with more than 60 Receiver Channels (filters), two of these boards are used. The bank-select jumper is reversed for the board that drives filters 61 and higher.

Note that the Module number (filter number) sent via the IEEE 488 bus will not necessarily agree with the physical location of the corresponding filter. The Receiver Controller has been programmed to know where each filter is physically located, despite the fact that the location may not agree with the filter's "number". This is more easily explained by the following example: If a Receiver has Channels 2, 3, 5, 7, 9, etc., with no intervening Channels, these five filters will be in positions 1, 2, 3, 4, and 5, respectively (despite the fact that they have IEEE 488 designations as Modules 1, 2, 4, 6, and 8).

The 74LS364 (in the lower left-hand corner of Figure 1-12) is a latch which holds the address of the selected filter. The latched address is decoded by the 74LS138 and the 7445 decoders (the 74LS138 handles the upper three bits of the address).

Because only one filter can be selected at a time, only one output from a single 7445 will be low -- all the other 7445 outputs (including those on the other board) will be high. The 7445 outputs are connected to an array of PIN diode switches which enables the output of only one RF filter in the entire Receiver filter bank.

1-2.12 Receiver Attenuator Latch Board

There are two types of attenuators in the Receiver: Distortion (audio) Attenuator and RF Attenuator. The Distortion Attenuator is a 0 to 127.5 dB attenuator, located in the RF Box of Figure 1-14, which attenuates the audio (15.75 KHz) distortion to be processed and detected by either the Commutative Filter Processor or the Composite Triple Beat Processor. The RF Attenuator is a 0 to 70 dB attenuator manufactured by Hewlett Packard.

The data from the Receiver Controller is latched into the two latches of Figure 1-13A. The 74LS364 is used to latch the Distortion Attenuator data. The 4401 is used to latch the RF Attenuator data.

The RF Attenuator is driven through an array of transistors. The transistors making up the RF Attenuator Driver are shown in Figure 1-13B.

1-2.13 Receiver RF Box

The Receiver RF Box is illustrated in Figure 1-14A, B, and C. Figure 1-4A contains the RF amplifiers and detector, as well as the first stage of the Audio (distortion) Attenuator.

Two Motorola RF amplifiers are separated by an RF PIN diode attenuator. The second stage of amplification is followed by an RF detector which, in turn, provides both the audio distortion signal and the feedback signal to run the RF Box's AGC loop. The proper RF level is maintained in the RF Box by controlling the drive to the PIN diode attenuator.

The detected audio is fed to a 127.5 dB Audio Attenuator composed of eight stages: 64, 32, 16, 8, 4, 2, 1 and .5 dB. The 64 dB stage is made up of two 32 dB sections. The first of these 32 dB sections is located in Figure 1-14A and is, in fact, located in the same physical compartment as the RF circuitry shown in this Figure.

The remainder of the Audio Attenuator is located in a separate compartment and is illustrated in Figure 1-14B. Each stage of

attenuation in Figure 1-14B functions by shunting a portion of the signal to ground whenever that stage's 2N3904 transistor is turned on (saturated). The lower four attenuator sections (4, 2, 1, and .5) do not require adjustments, but the upper stages (64, 32, 16, and 8) do require them. In order to insure the accuracy of the distortion measurements, the upper stages must be adjusted to a tolerance of better than .5 dB, therefore, it is not recommended that these adjustments be disturbed unless the proper test equipment is on hand.

The final section of Figure 1-14 (Figure 1-14C) is the AGC Comparitor circuitry. This circuit monitors the Signal Strength voltage from the RF Box (Figure 1-14A). If the signal is too strong or too weak, the request for MORE ATTENUATION or LESS ATTENUATION is sent to the Reveiver Controller, as appropriate. Note that the AGC signals have no direct effect on the RF Attenuators. The only time the Receiver Controller will read the AGC signals is just prior to making a distortion measurement. If the signal strength changes later, the Receiver Controller will not respond to those changes until the start of the next distortion measurement.

1-2.14 Receiver Tone Generator

The Schematic of the Receiver Tone Generator is illustrated in Figure 1-15. The Tone Generator is a high gain audio amplifier which picks up the 15.75 KHz modulation (or the distortion beat note) and amplifies it to a level useable by the Commutative Filter Processor of Figure 1-16.

1-2.15 Commutative Filter Processor

The Commutative Filter Processor is illustrated in Figure 1-16. The 15.75 KHz tone (or the audio distortion beat note) from the Tone Generator is amplified then fed to an NE565 phase-locked loop. The phase-locked loop free runs at about 15 to 16 KHz, but, in the presence of a Tone Generator signal, it locks onto the input frequency.

The distortion audio (from RF Box's Distortion Attenuator) is amplified and split into two phases by a pair of amplifiers. The phase-locked circuitry (mentioned above) further subdivides the amplified signal and commutates the signal into phase-locked quadrature (every 90 degrees) components.

The quadrature outputs are then combined and fed to an audio amplitude detector. The output of the detector is fed to a window comparitor which determines whether the detected signal is

too large, too small, or acceptable. The output signals (MORE ATTENUATION and LESS ATTENUATION) are routed back to the Receiver Controller board where they are used to determine what changes, if any, should be made to the Audio (distortion) Attenuator.

1-2.16 Composite Triple Beat Processor

The Composite Triple Beat Processor is illustrated in Figure 1-17. It consists basically of an audio filter followed by a detector and a window comparitor. The detector and window comparitor function identically to those in the Commutative Filter Processor (above).

1-3. Repair

Repairs to the equipment fall into four basic categories: repair of the main frame harnessing, repair of the Generator Modules, repair of the RF Box, and repair of the support electronics (everything else).

1-3.1 Repair of Main Frame Harnessing

Figures 1-20 and 1-21 illustrate the main frame wiring for the ASX-16 portion and the AR-12 portion (Generator and Receiver, respectively). Only a small portion of the coaxial connections are shown in these diagrams.

If a signal does not appear to be getting from its source to its destination, first check for continuity between the appropriate points. If the signal path is continuous, check for shorts to adjacent pins on all connectors that contain the "faulty" signal.

Be certain to check that all plugs are firmly seated and that they are installed in the correct location and in the correct direction. It is possible (through vibration) for the plugs to eventually work themselves up, off their mating pins. This is especially likely after the equipment has been subjected to the rigors of shipping.

1-3.2 Repair of Generator Modules

When it has been determined that a Generator Module is malfunctioning, it must first be determined whether the cause of the problem is in the module itself or in the Module Driver board that is driving it. This can be most easily accomplished

by swapping the plugs between the "bad" module and the module next to it. If the problem stays with the module after the swap, the problem is in the module, itself. If the problem appears in the "good" module, and the "bad" module works properly, the problem is in the Module Driver board. Do not forget to swap the plugs back after making the above test.

There are four ways that the module can fail: no output power, always CW, always modulated, and improper response to the "L" (leveling) command.

Any one of these problems can be caused by bad continuity between the Module Driver board and the module. First check the plug and the wires to make sure the signal path is continuous.

If the module does not receive the correct modulation levels (via the daisy-chained coaxial connections), its output may be low (off) or high (cw) whenever the module is put into the "M" (modulated) mode of operation. If there is a break in this coaxial line, all modules following the defective module will exhibit the same bad characteristics.

Another cause of no output from a module is a stalled oscillator. Carefully retune the first adjustment (closest to the front panel), located on the bottom of the defective module. If the module suddenly puts out a signal, the oscillator was stalled. Readjust the oscillator to a point where it will not stall when it is turned on ("C") and off ("P") using the QOFF mode (see Section II).

If the module's output level is slightly higher or lower than that of its neighbors, its output can be brought to the desired level using the level adjustment (furthest from the front panel) located on the bottom of the module. Be sure that you do not alter the filter adjustments. The filter is mounted on the rear of the module.

If the malfunction still exists, it will be necessary to remove the module from the Generator. Consult Section 1-2.5 for more information on the Generator Modules.

If the problem is in the Module Driver board (see Section 1-2.4 for details), the cause of the problem can most easily be located by swapping the IC's from the bad section with those of a good section until the bad IC's is (are) located. Check the board for continuity if none of the IC's are bad.

1-3.3 Repair of RF Box

There are three basic parts to the RF Box: RF amplifier and audio detector, audio attenuator, and AGC comparitors. Consult Section 1-2.13 for details on how these three sections operate.

The AGC window comparitors determine the ultimate RF Attenuator setting. The window should be approximately 12 to 13 dB wide. The RF Attenuator has 10 dB resolution. If the AGC window is set too tightly (less than or equal to 10 dB), the Receiver Controller will be caught in an endless loop in which it will be told by the AGC comparitors to put in 10 dB more attenuation, then, after putting in the 10 dB, it will be told to take it out. This will be followed, cyclically, by the command to put it back in again, etc.

The proper operation of each of the audio attenuators can be determined by enabling one stage at a time (64, 32, 16, 8, 4, 2, 1, or .5) and by observing the change on the audio output. The "within-spec" commands covered in SECTION II of this manual will permit the testing of all audio attenuator sections (except the .5 dB section) on an individual basis.

1-3.4 Repair of the Support Electronics

Repairs to the support electronics can most readily be accomplished by reading the appropriate sub-Section 1-2. Once the proper operation of the malfunctioning circuitry is understood, the fault can be isolated by observation with an oscilloscope or by the substitution of IC's. The only IC's which cannot be substituted for their "duplicates" on other boards are the ROM's (IC's 4A, 4B and 4C) on the two Controller boards.

1-4. Adjustments to the Generator Modules

Figure 1-26 illustrates the location of each adjustment in the Generator Module. The schematic of the Module is illustrated in Figure 1-6. A brief description of the operation of the Generator Module is given in Section 1-2.5.

The following procedure should be followed when making adjustments to the Generator Modules.

Note: For easiest adjustment, always start with the lowest frequency module and work up to the highest frequency module without skipping.

(For the purposes of this discussion, we will assume Module 66 is being adjusted. To adjust any other Module, substitute its number in place of "66").

1) After resetting the Model ASX-16, turn all Generator Modules on CW using the "CO" command. Then, set the Generator Modules to their highest output levels using the command, "LO,127" (do not forget to complete the handshake by reading the response, which should be "G"). This will place all Generator Modules on step 255. Set the RF Attenuator to 10 dB using the command "A10". Allow sufficient time for all Generator Modules to attain their normal operating temperature.

2) Send the command "PO" to the Model ASX-16. This will lower the carriers of all Modules at least 35 dB down from their normal levels. Send the command "C66" to bring the carrier of Module 66 back to its normal, unmodulated operating level. Connect the output of the Model ASX-16 to a Frequency Counter.

3) Generally, the output frequency of a Module is not critical unless a channel is being used for Discrete Second Order or Discrete Third Order measurements. As the FREQUENCY ADJUST control is rotated over its range, the Generator Module's oscillator will begin to stall at two points. If the output frequency is not critical, leave the FREQUENCY ADJUST control midway between the two "stall" points. If the frequency is critical, turn the FREQUENCY ADJUST control to obtain the desired output.

4) Check the Generator Module to be sure its oscillator will not stall at the new frequency. This is done by repeatedly connecting and disconnecting the plug that runs from the Generator Module to the Module Driver Board. If the Module's

oscillator does not come on every time the plug is reinserted, readjust the FREQUENCY ADJUST control until a stable operating region is found. Leave the FREQUENCY ADJUST control in the center of the "stable" region.

5) Connect the RF output of the Model ASX-16 to any instrument capable of displaying the output amplitude (such as a Spectrum Analyzer, Field Strength Meter, Model R-12, or Model R-75).

6) Starting with the control closest to the FREQUENCY ADJUST control, rotate each PEAK ADJUSTMENT control to obtain the strongest carrier on this frequency. Set the AMPLITUDE ADJUST control to its maximum setting.

7) Rotate the FILTER ADJUSTMENTS to obtain the strongest carrier on this frequency.

8) Repeat steps 6 and 7 until further adjustments create no improvement.

9) Repeat steps 2 through 8 for all other modules. When the last module has been adjusted, re-peak every Module's FILTER ADJUSTMENTS, starting with the lowest-frquency module and working up to the highest-frequency module.

10) After all Modules have been peaked, restore them to their "middle" position by sending the command, "LO,-127" (do not forget to complete the handshake by reading the response, which should be "G"). This will place all Generator Modules on step 128.

11a) If you will be using a Spectrum Analyzer, Field Strength Meter, Model R-12, or Model R-75, (or similar device), to level the Model ASX-16, send the command "CO", which will place all Modules on in their CW mode.

or

11b) If you will be using a Power Meter (or similar device) to level the Model ASX-16, send the commands "PO" and "C66" (substitute the appropriate Module number for "66") which will place just one carrier on its CW mode -- all the other carriers will be at least 35 dB down. When measuring the power of the next Module, send the commands "PO" and "C67" (substitute the appropriate Module number for "67").

12) Locate the Module with the lowest output level.

```
CHANNEL   36     ATTENUATION    5      LEVEL   165      COUNT   231.85

ERROR 159 IN 190  Numeric data not received
                 |RENumber      |FIND ""       |CHANGE "" TO "|INDENT
   SCRATCH       |LOAD ""       |LOAD BIN ""   |LIST BIN      |RE-STORE ""
```

Com Ass

Timeout

You will use this one as your "reference." Turn the reference Module's AMPLITUDE ADJUST CONTROL to bring its carrier 2 dB lower than its peak. Do not adjust any other control on the reference Module.

13) Depending on your particular application, it may be desirable to set all Generator Carriers to the same amplitude, or it may be desirable to adjust them for a particular slope. Use the AMPLITUDE ADJUST controls of the remaining Modules to adjust the carrier for the appropriate output relationship (level or sloping). Do not adjust any other control on the Modules. If a module has insufficient range on its AMPLITUDE ADJUST control, use that Module as your reference, then try again.

14) Check again to be sure none of the modules "stall" when they are unplugged from the Module Driver Board. If no Module stalls, the ASX-16 is now adjusted. If a module stalls, go back and retune its FREQUENCY ADJUST control.

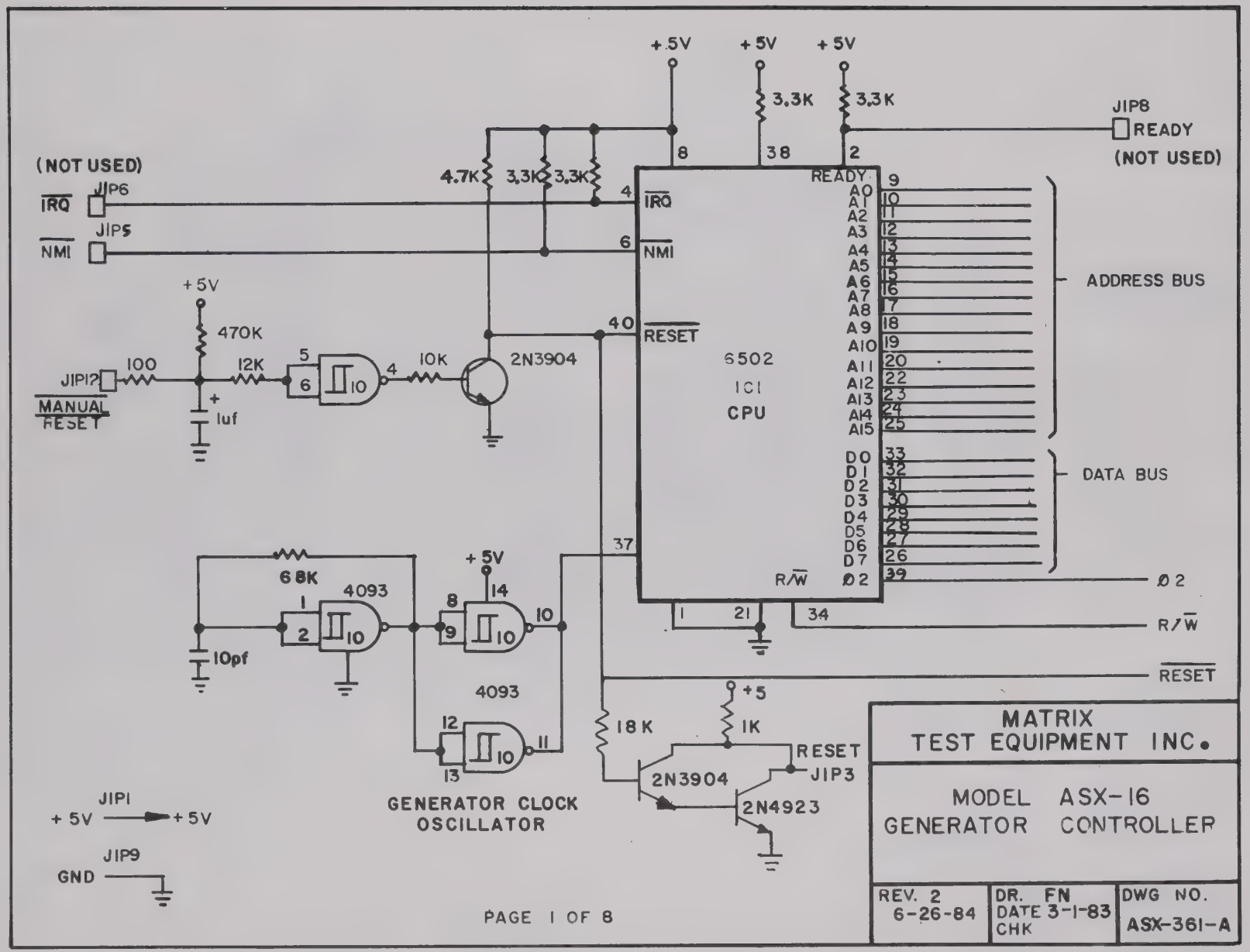
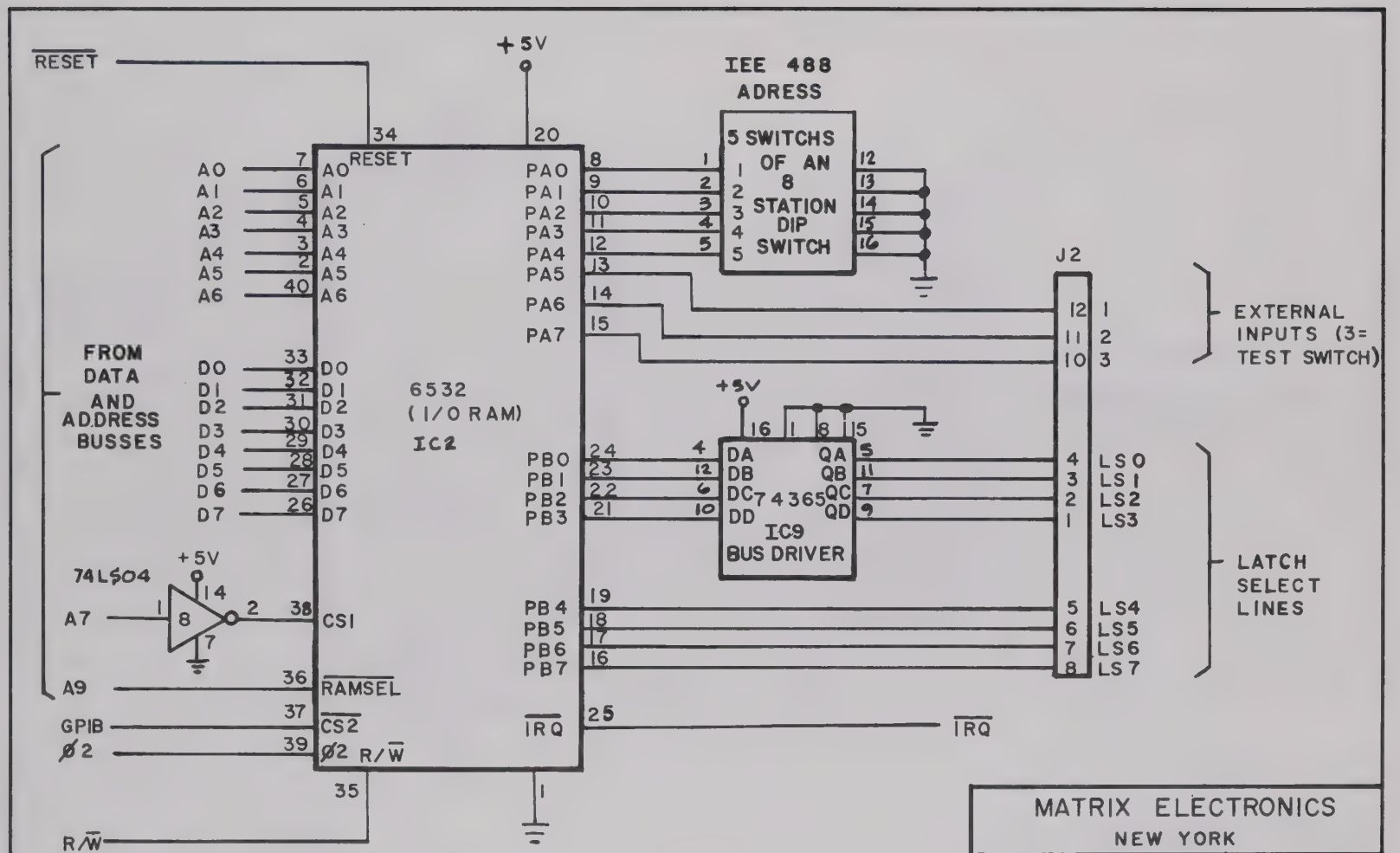

+5V
+5V
+5V
3.3K
3.3K
JIP8
READY
(NOT USED)
(NOT USED)
4.7K
3.3K
3.3K
IRQ
JIP6
NMI
JIP5
8
38
2
READY
4
IRQ
6
NMI
40
RESET
6502
ICI
CPU
A0
A1
A2
A3
A4
A5
A6
A7
A8
A9
A10
A11
A12
A13
A14
A15
ADDRESS BUS
D0
D1
D2
D3
D4
D5
D6
D7
DATA BUS
R/W
Ø2
37
1
21
34
Ø2
R/W
RESET
+5V
470K
JIP12
100
12K
5
6
10
4
10K
2N3904
MANUAL RESET
1uf
68K
4093
1
2
10
+5V
14
8
9
10
10pf
4093
12
13
11
GENERATOR CLOCK OSCILLATOR
+5
18K
1K
RESET
JIP3
2N3904
2N4923
JIP1
+5V
+5V
JIP9
GND
MATRIX
TEST EQUIPMENT INC.
MODEL ASX-16
GENERATOR CONTROLLER
REV. 2
6-26-84
DR. FN
DATE 3-1-83
CHK
DWG NO.
ASX-361-A
PAGE 1 OF 8

FIGURE 1-3

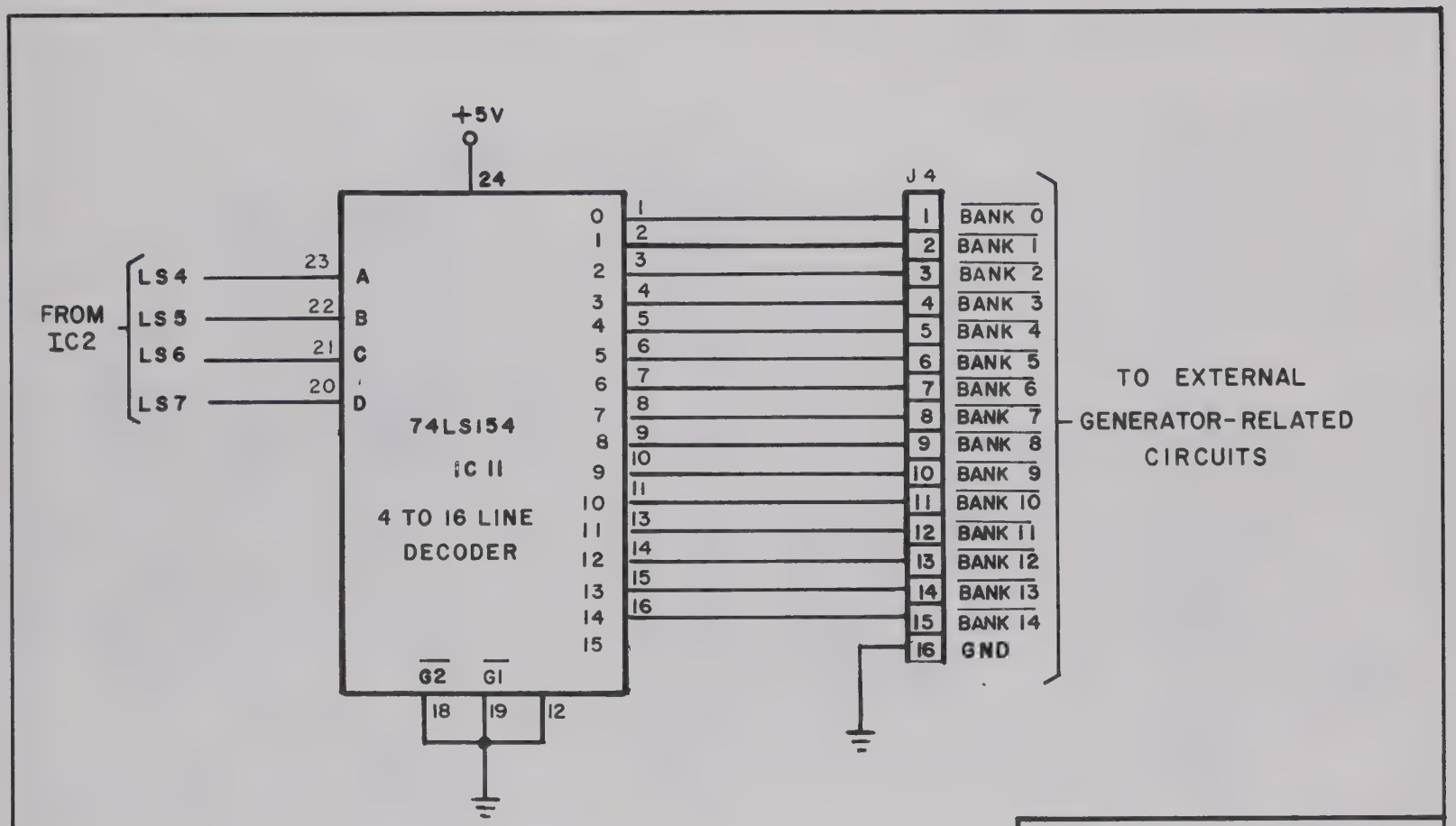


MATRIX ELECTRONICS
NEW YORK

MODEL ASX-16
GENERATOR CONTROLLER

REV	DR. FN	DWG NO
1	DATE 3-1-83	ASX-362-A
	CHK.	

FIGURE 1-3(CONT.)



MATRIX ELECTRONICS NEW YORK		
MODEL ASX-16 GENERATOR CONTROLLER		
REV. 1	DR. FN DATE 3-1-83 CHK.	DWG. NO. ASX-363-A

FIGURE 1-3(CONT.)

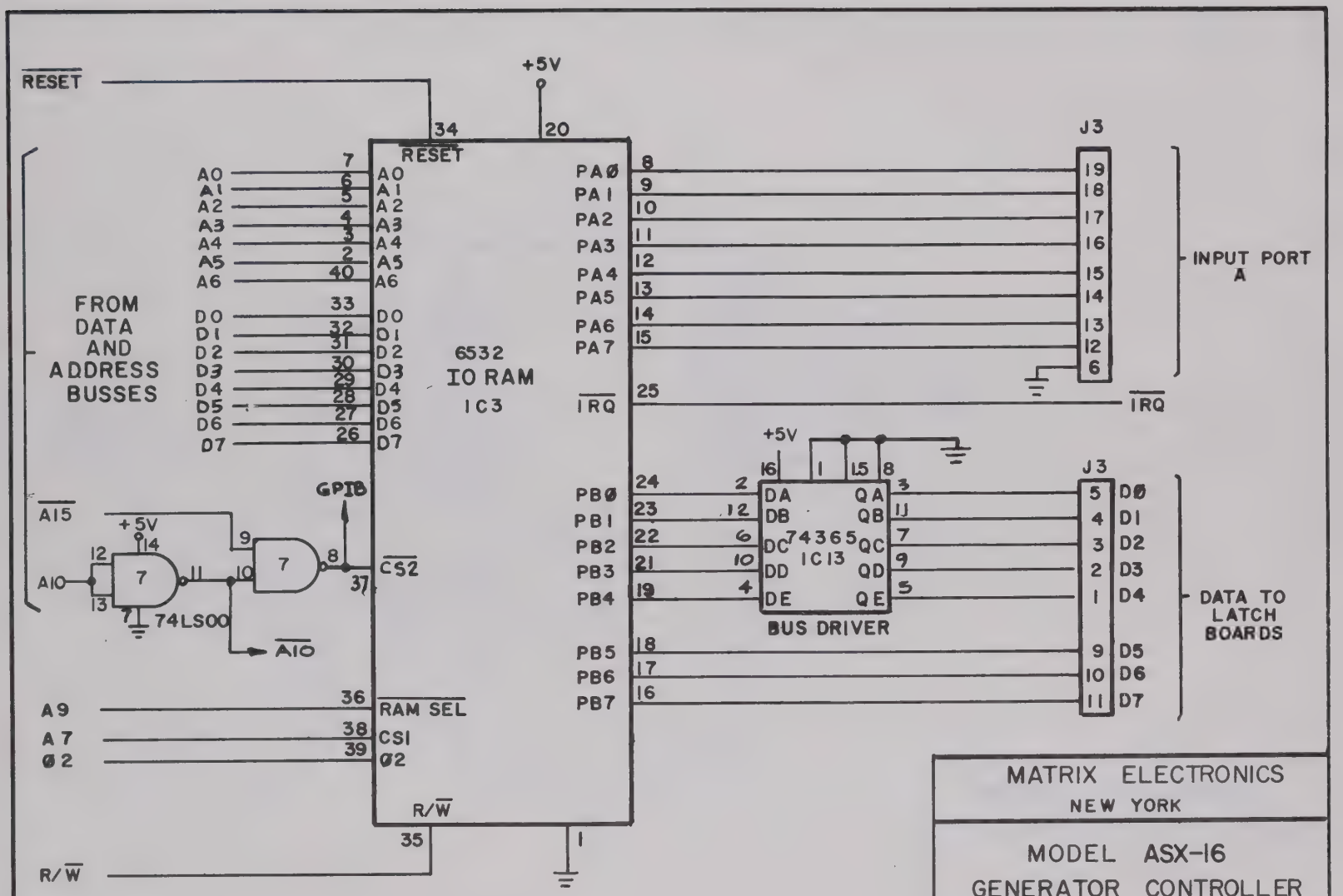
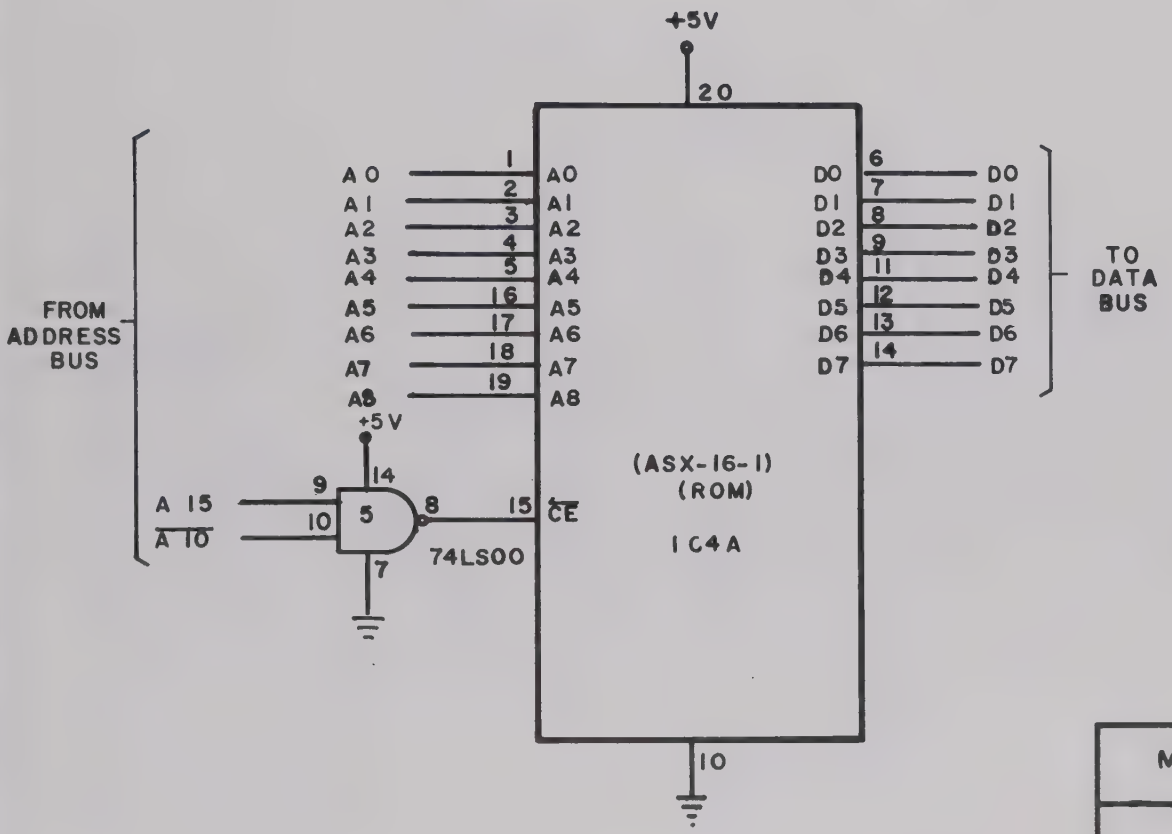
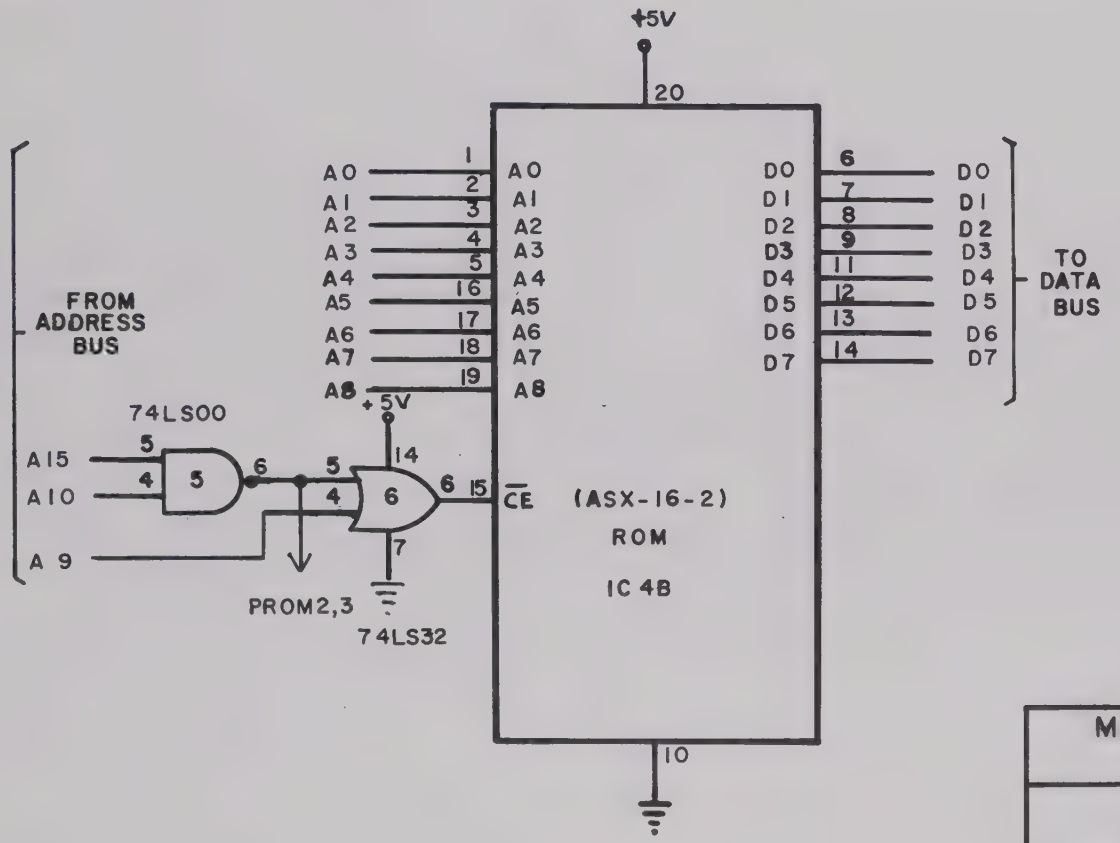


FIGURE 1-3 (CONT.)



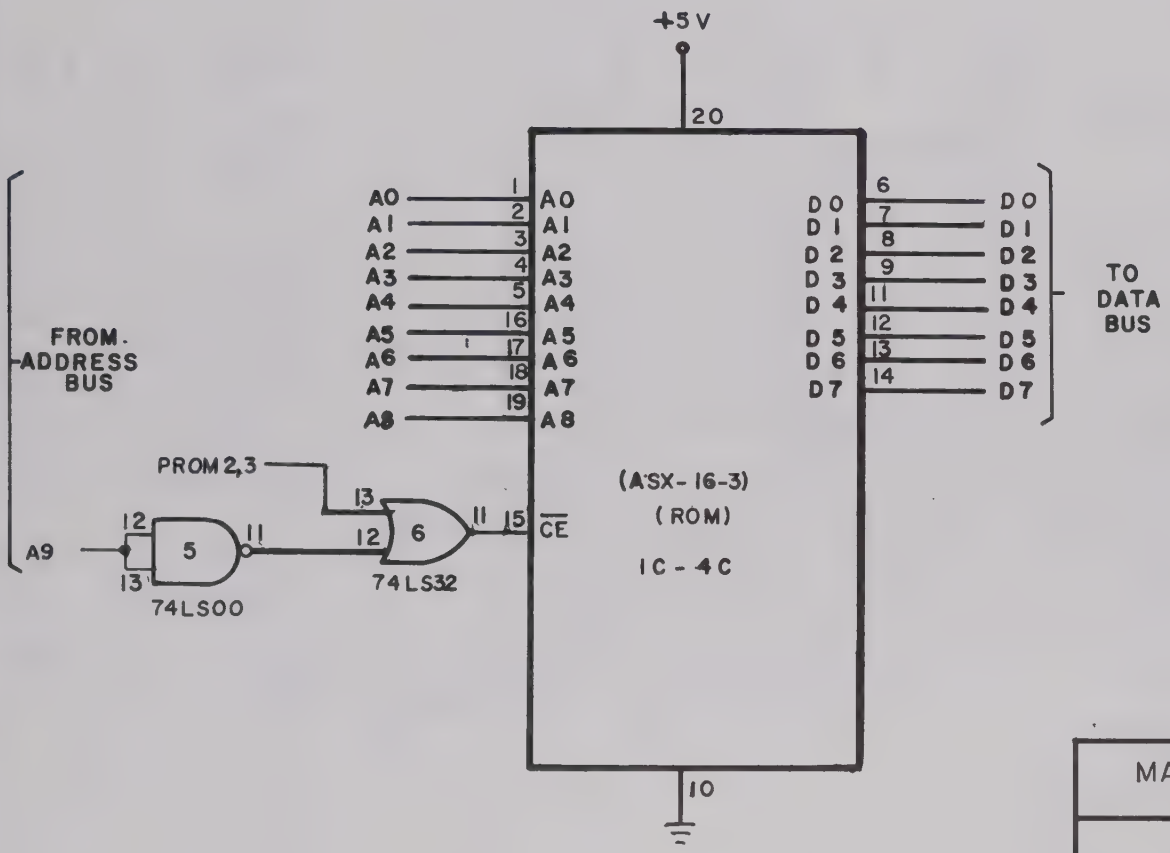
MATRIX ELECTRONICS NEW YORK		
MODEL ASX-16 GENERATOR CONTROLLER		
REV. 1	DR. FN DATE 3-1-83 CHK.	DWG. NO. ASX-365-A

FIGURE 1-3(CONT.)



MATRIX ELECTRONICS NEW YORK		
MODEL ASX-16 GENERATOR CONTROLLER		
REV. 1	DR. FN DATE 3-1-83 CHK.	DWG. NO. ASX-366-A

FIGURE 1-3(CONT.)



MATRIX ELECTRONICS NEW YORK		
MODEL ASX-16 GENERATOR CONTROLLER		
REV. 1	DR. FN DATE 3-1-83 CHK	DWG. NO. ASX-367-A

FIGURE 1-3 (CONT.)

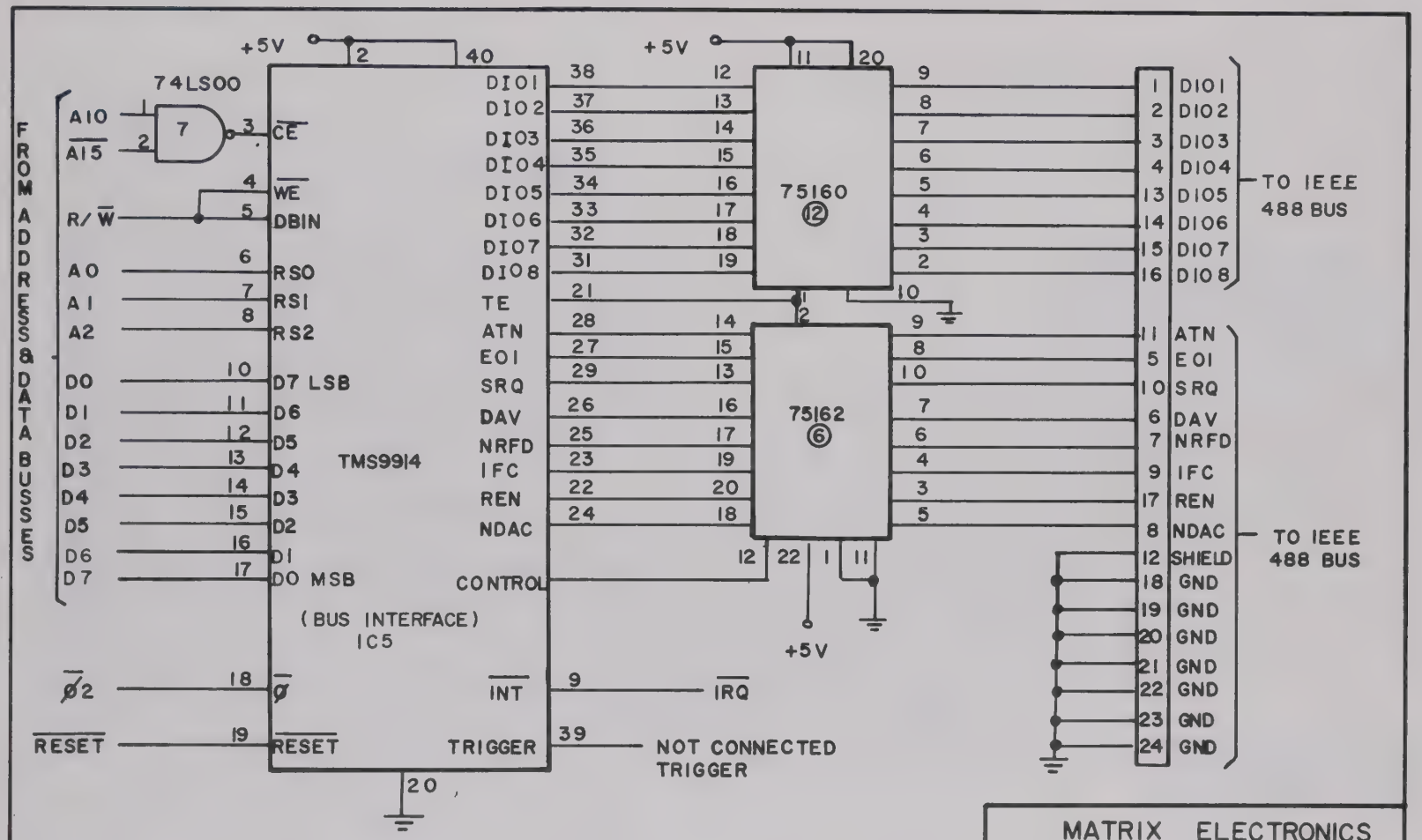
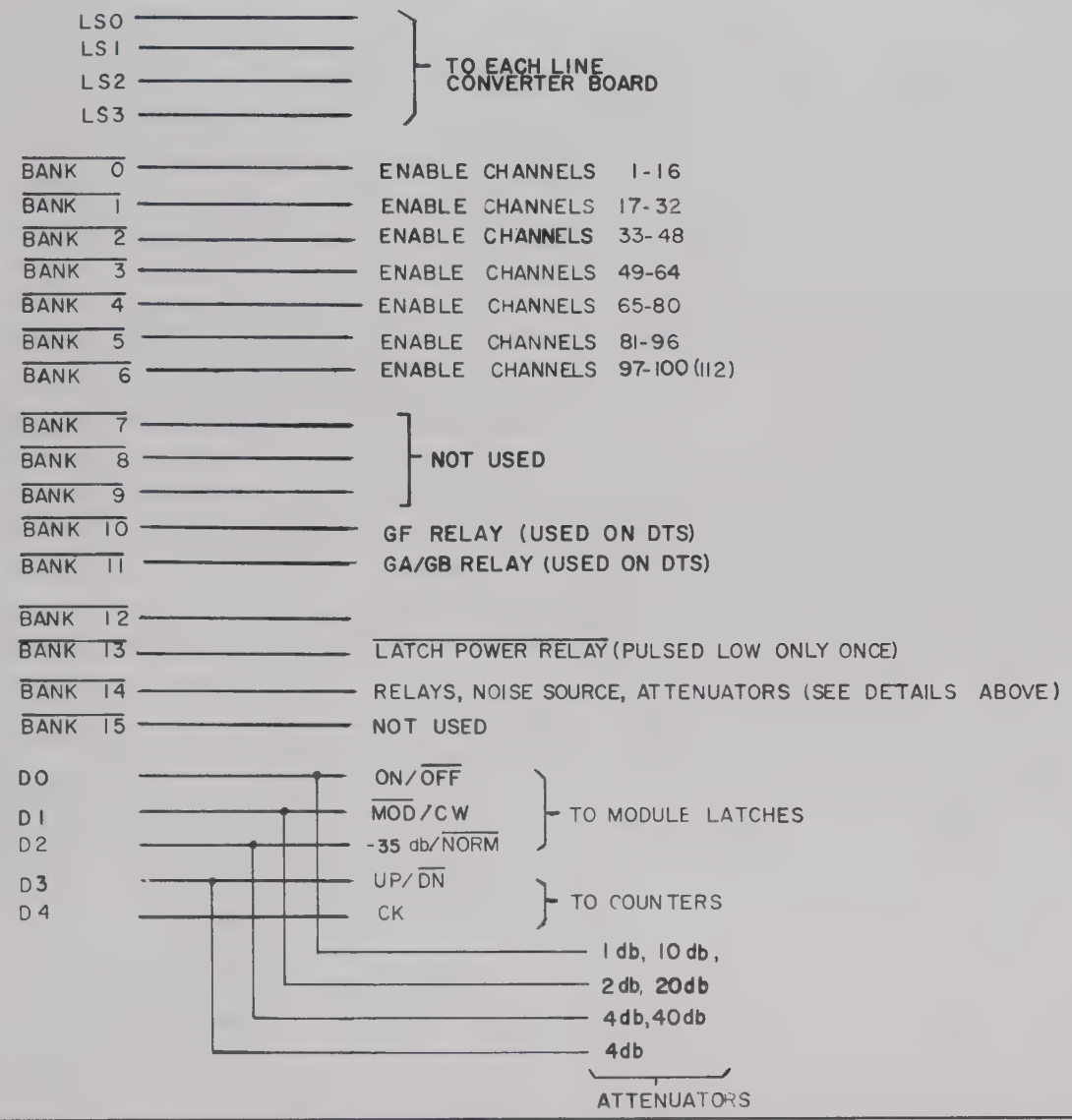


FIGURE 1-3(CONT.)



BNK 14	LS3	LS2	LS1	LS0	DATA OUT
0	0	1	1	0	UNITS ATTEN.
0	0	1	1	1	TENS ATTEN.

NOTE: SOME ADDRESSES HAVE BEEN SKIPPED (ABOVE) TO ALLOW FOR POSSIBLE FUTURE EXPANSION.

MATRIX
TEST EQUIPMENT INC.

MODEL ASX-16
GENERATOR CONTROLLER
INTERFACE WIRING

REV. 2	DR. FN	DWG NO.
6-27-84	DATE 3-1-83 CHK.	ASX-369-B

FIGURE 1-4

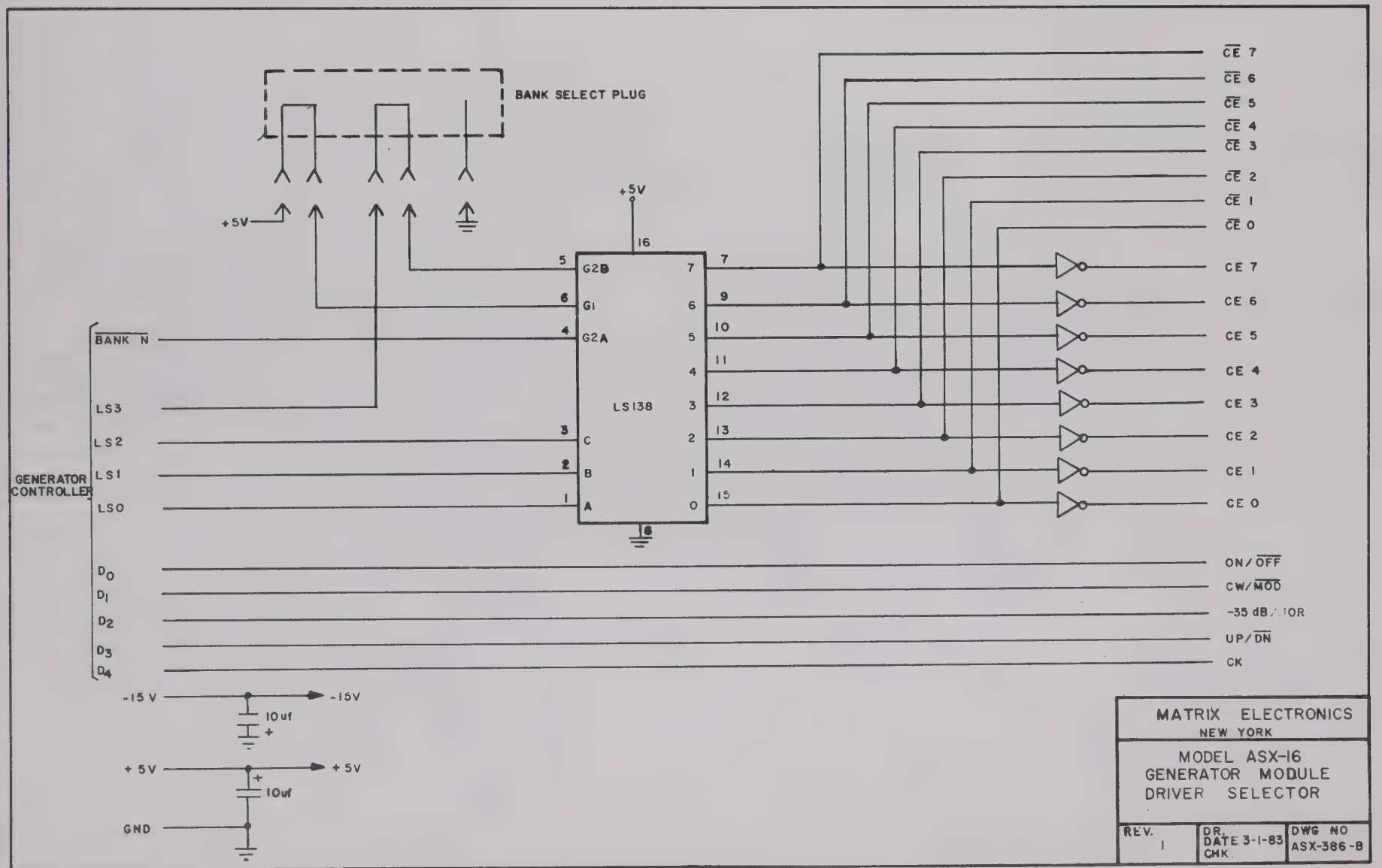

BANK SELECT PLUG
+5V
+5V
16
5
G2B
6
G1
4
G2A
LS138
3
C
2
B
1
A
8
7
6
5
4
3
2
1
0
7
9
10
11
12
13
14
15
BANK N
LS3
LS2
LS1
LS0
GENERATOR CONTROLLER
D0
D1
D2
D3
D4
CE 7
CE 6
CE 5
CE 4
CE 3
CE 2
CE 1
CE 0
CE 7
CE 6
CE 5
CE 4
CE 3
CE 2
CE 1
CE 0
ON/OFF
CW/MOD
-35 dB/ IOR
UP/DN
CK
-15 V
-15V
10uf
+
+ 5V
+ 5V
+
10uf
GND
MATRIX ELECTRONICS
NEW YORK
MODEL ASX-16
GENERATOR MODULE
DRIVER SELECTOR
REV.
1
DR.
DATE 3-1-83
CHK
DWG NO
ASX-386-B

FIGURE 1-5A

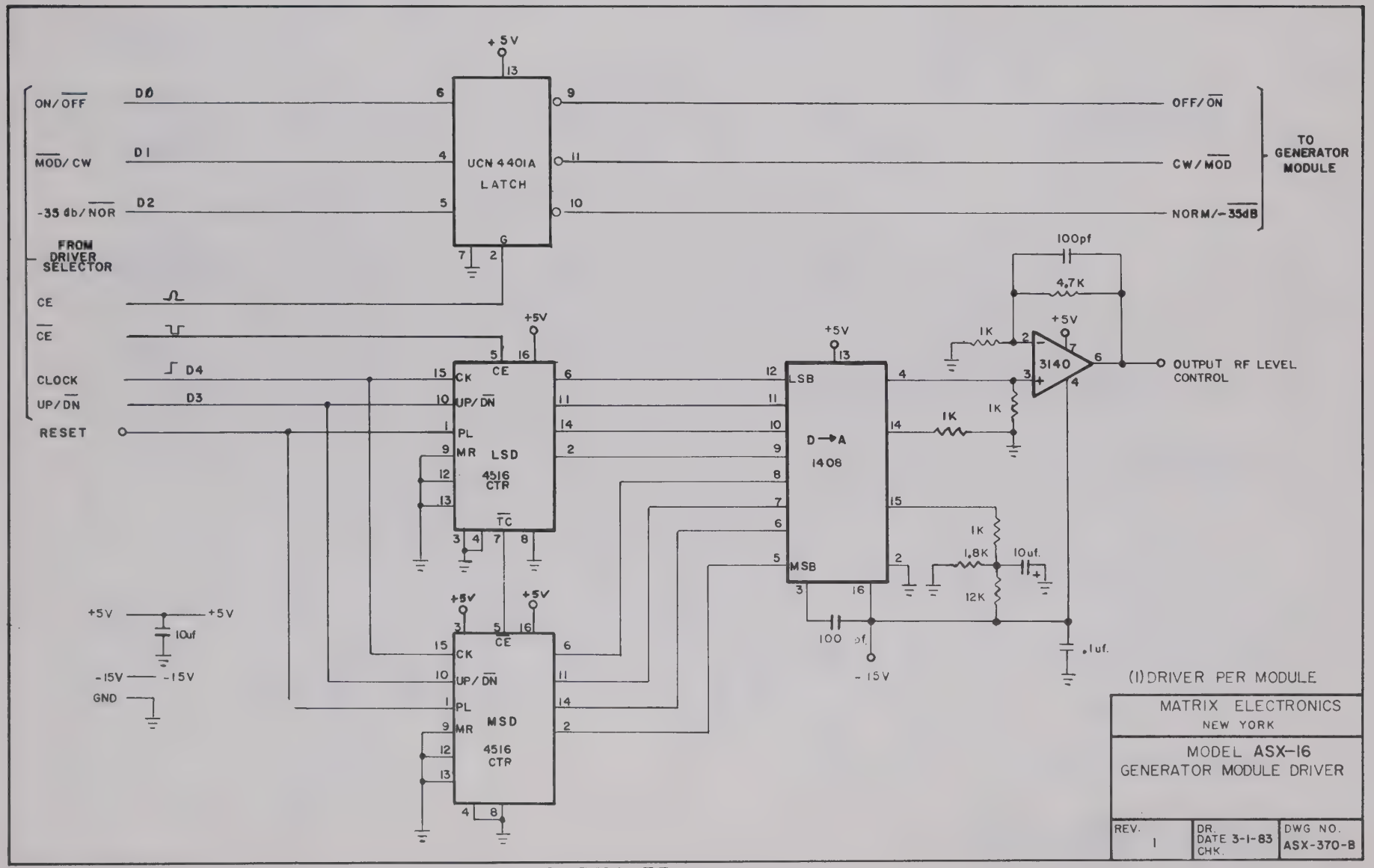

+5V
ON/OFF
D0
MOD/CW
D1
-35 db/NOR
D2
UCN 4401A
LATCH
OFF/ON
CW/MOD
NORM/-35dB
TO GENERATOR MODULE
FROM DRIVER SELECTOR
CE
CLOCK
D4
UP/DN
D3
RESET
LSD
4516 CTR
MSD
4516 CTR
D→A 1408
LSB
MSB
100pf
4.7K
1K
3140
OUTPUT RF LEVEL CONTROL
1.8K
10uf.
12K
100 pf.
-15V
.1uf.
10uf
GND
(1) DRIVER PER MODULE
MATRIX ELECTRONICS
NEW YORK
MODEL ASX-16
GENERATOR MODULE DRIVER
REV. 1
DR.
DATE 3-1-83
CHK.
DWG NO. ASX-370-B

FIGURE 1-5B

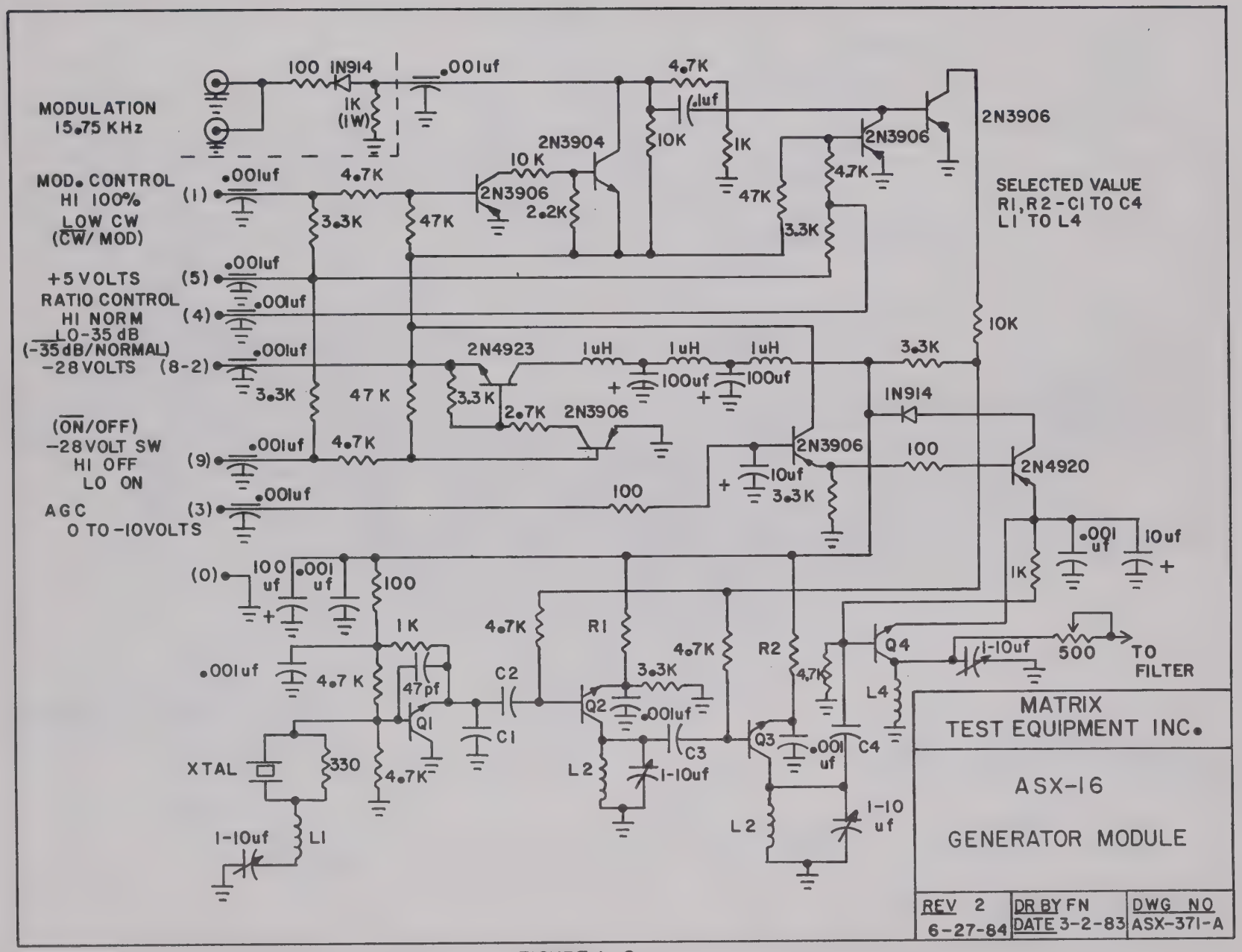

MODULATION
15.75 KHz
100
IN914
.001uf
1K
(1W)
4.7K
.1uf
2N3906
2N3906
10K
1K
2N3904
10 K
MOD. CONTROL
HI 100%
LOW CW
(CW/MOD)
(1)
.001uf
4.7K
2N3906
2.2K
47K
4.7K
3.3K
3.3K
47K
SELECTED VALUE
R1, R2 - C1 TO C4
L1 TO L4
+5 VOLTS
(5)
.001uf
RATIO CONTROL
HI NORM
LO -35 dB
(-35 dB/NORMAL)
(4)
.001uf
10K
-28 VOLTS
(8-2)
.001uf
2N4923
1uH
1uH
1uH
3.3K
3.3K
47 K
3.3K
2.7K
2N3906
100uf
100uf
(ON/OFF)
-28 VOLT SW
HI OFF
LO ON
(9)
.001uf
4.7K
IN914
2N3906
100
2N4920
10uf
3.3K
AGC
0 TO -10 VOLTS
(3)
.001uf
100
(0)
100 uf
.001 uf
100
.001 uf
10uf
1K
1K
4.7K
R1
4.7K
R2
Q4
1-10uf
500
TO FILTER
.001uf
4.7 K
47pf
C2
3.3K
4.7K
L4
Q1
Q2
.001uf
Q3
.001 uf
C4
XTAL
330
4.7K
C1
C3
L2
1-10uf
L2
1-10 uf
1-10uf
L1
MATRIX
TEST EQUIPMENT INC.
ASX-16
GENERATOR MODULE
REV 2
6-27-84
DR BY FN
DATE 3-2-83
DWG NO
ASX-371-A

FIGURE 1-6

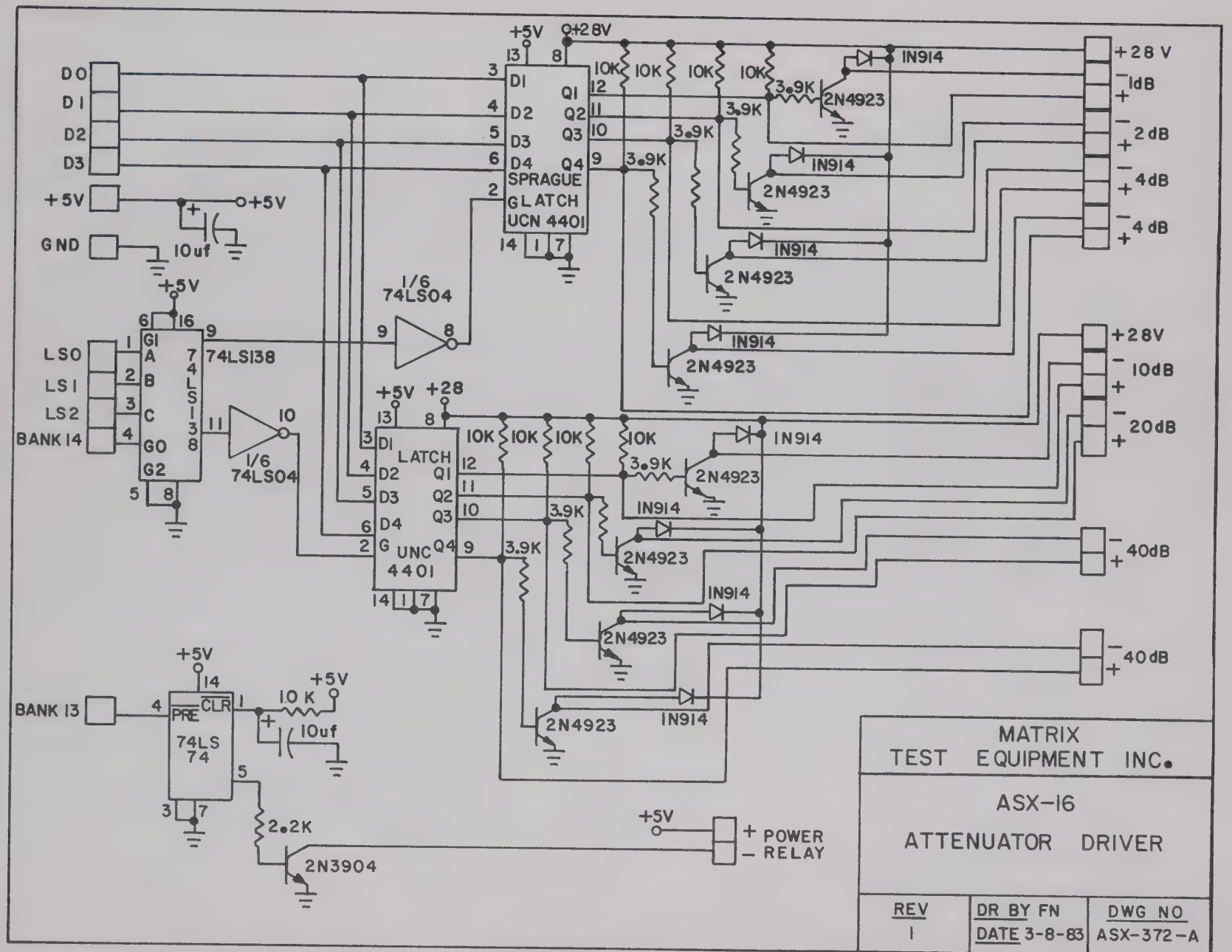

D0
D1
D2
D3
+5V
GND
10uf
+28V
SPRAGUE
GLATCH
UCN 4401
DI
D2
D3
D4
Q1
Q2
Q3
Q4
LATCH
1/6
74LS04
74LS138
LS0
LS1
LS2
BANK 14
GO
G2
10K
3.9K
2N4923
IN914
+28 V
1dB
2dB
4dB
4 dB
10dB
20dB
40dB
40dB
BANK 13
74LS
74
PRE
CLR
10 K
2.2K
2N3904
+ POWER
– RELAY
MATRIX
TEST EQUIPMENT INC.
ASX-16
ATTENUATOR DRIVER
REV
1
DR BY FN
DATE 3-8-83
DWG NO
ASX-372-A

FIGURE 1-7

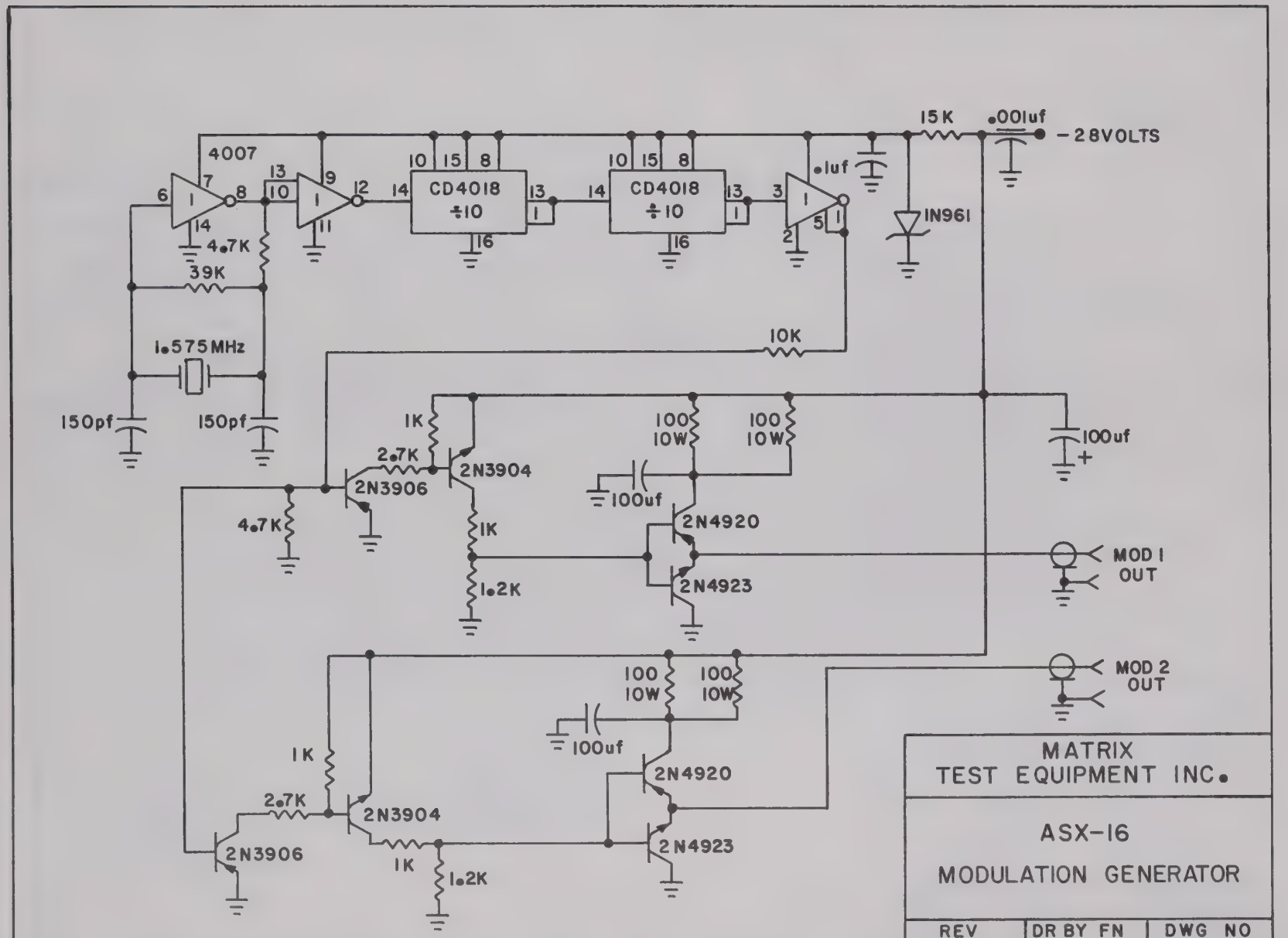

4007
CD4018
÷10
CD4018
÷10
15K
.001uf
-28VOLTS
.1uf
IN961
4.7K
39K
1.575MHz
150pf
150pf
10K
1K
2.7K
2N3904
2N3906
4.7K
1K
1.2K
100
10W
100
10W
100uf
2N4920
2N4923
100uf
MOD 1
OUT
MOD 2
OUT
100
10W
100
10W
100uf
1K
2.7K
2N3904
2N3906
1K
1.2K
2N4920
2N4923
MATRIX
TEST EQUIPMENT INC.
ASX-16
MODULATION GENERATOR
REV
1
DR BY FN
DATE 3-3-83
DWG NO
ASX-390-A

FIGURE 1-9

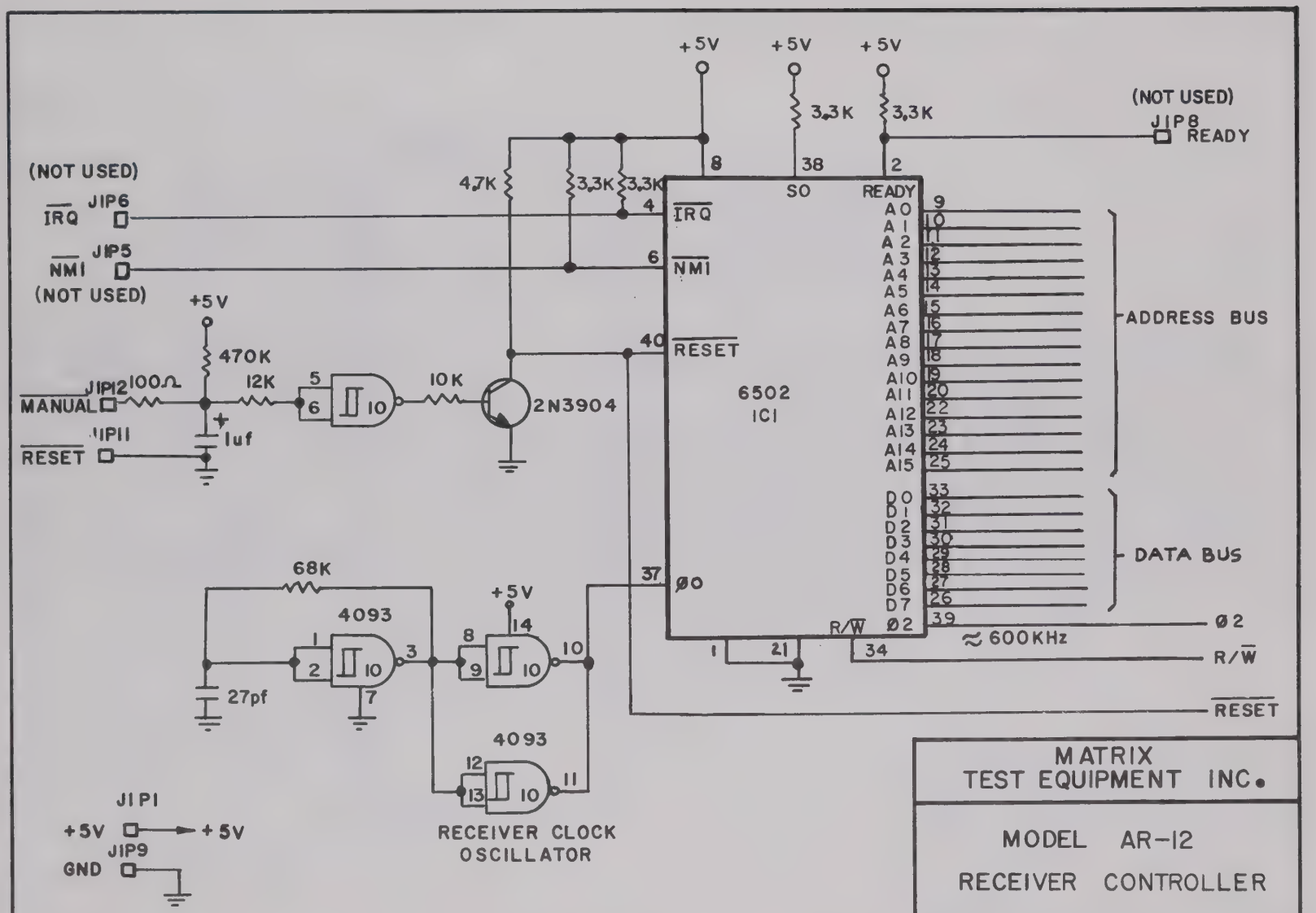

+5V
+5V
+5V
3.3K
3.3K
(NOT USED)
J1P8
READY
(NOT USED)
IRQ J1P6
NMI J1P5
(NOT USED)
4.7K
3.3K
3.3K
8
38
2
SO
READY
4
IRQ
6
NMI
40
RESET
6502
IC1
A0
A1
A2
A3
A4
A5
A6
A7
A8
A9
A10
A11
A12
A13
A14
A15
ADDRESS BUS
D0
D1
D2
D3
D4
D5
D6
D7
DATA BUS
37
Ø0
R/W
Ø2
39
34
1
21
≈ 600KHz
Ø2
R/W
RESET
+5V
470K
J1P12
100Ω
MANUAL
12K
5
6
10K
2N3904
J1P11
RESET
1uf
68K
4093
+5V
27pf
4093
RECEIVER CLOCK
OSCILLATOR
J1P1
+5V
+5V
J1P9
GND
MATRIX
TEST EQUIPMENT INC.
MODEL AR-12
RECEIVER CONTROLLER
REV 2
6-27-84
DR
DATE
CHK.
DWG NO
AR-373-A
PAGE 1 OF 6

FIGURE 1-10

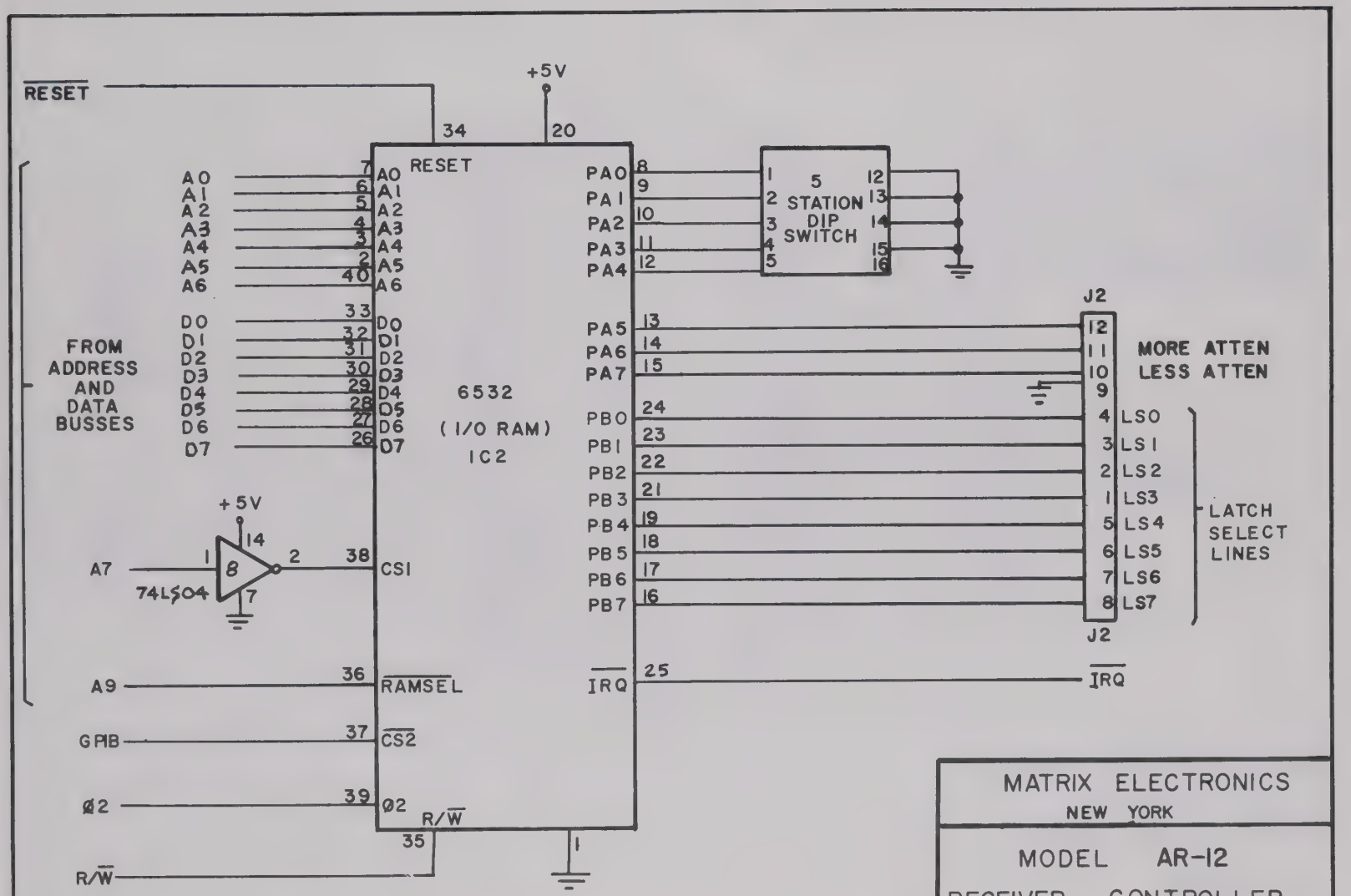
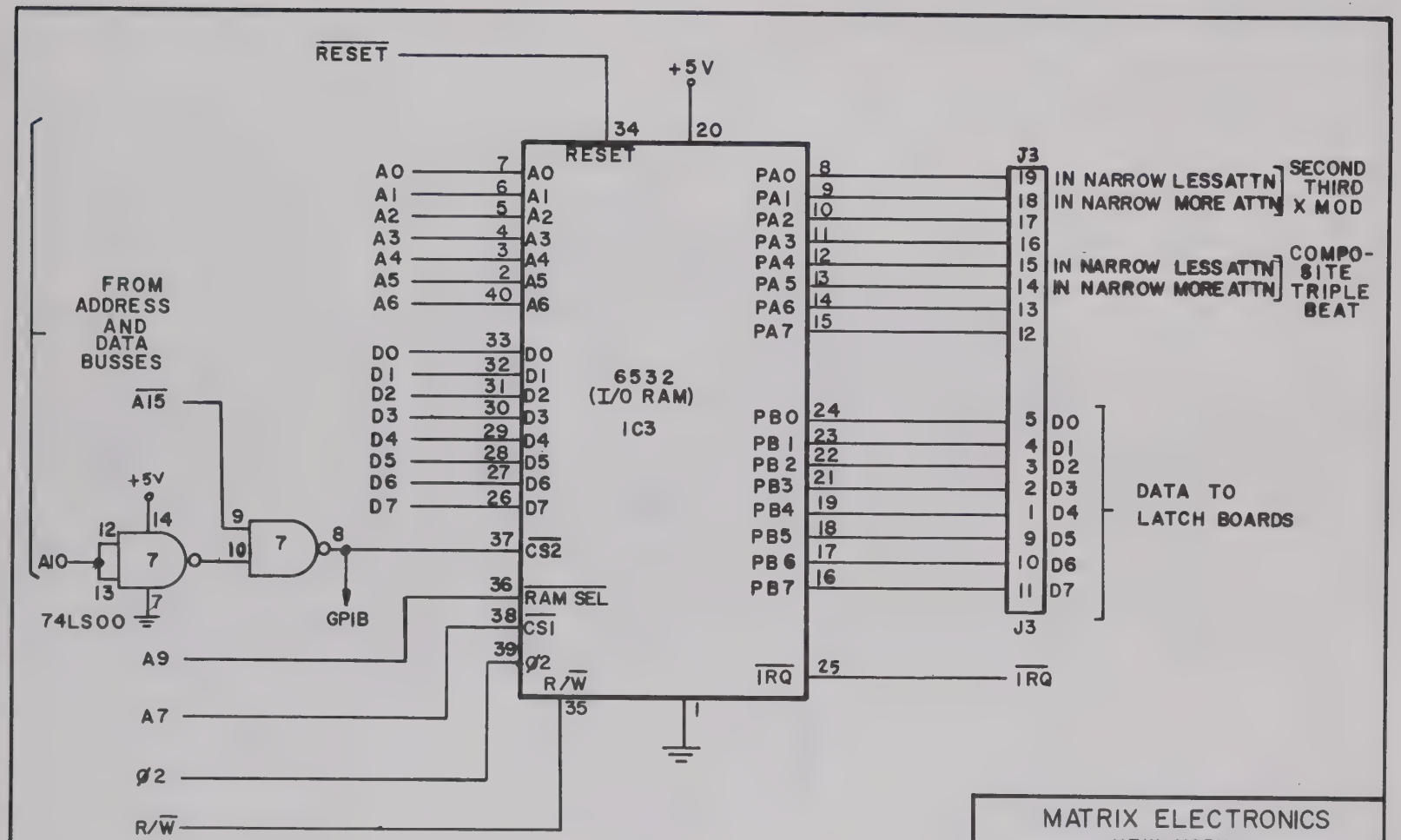


FIGURE 1-10(CONT.)



MATRIX ELECTRONICS NEW YORK		
MODEL AR-12 RECEIVER CONTROLLER		
REV. 1	DR DATE 3-8-83 CHK	DWG NO AR-375-A

FIGURE 1-10(CONT.)

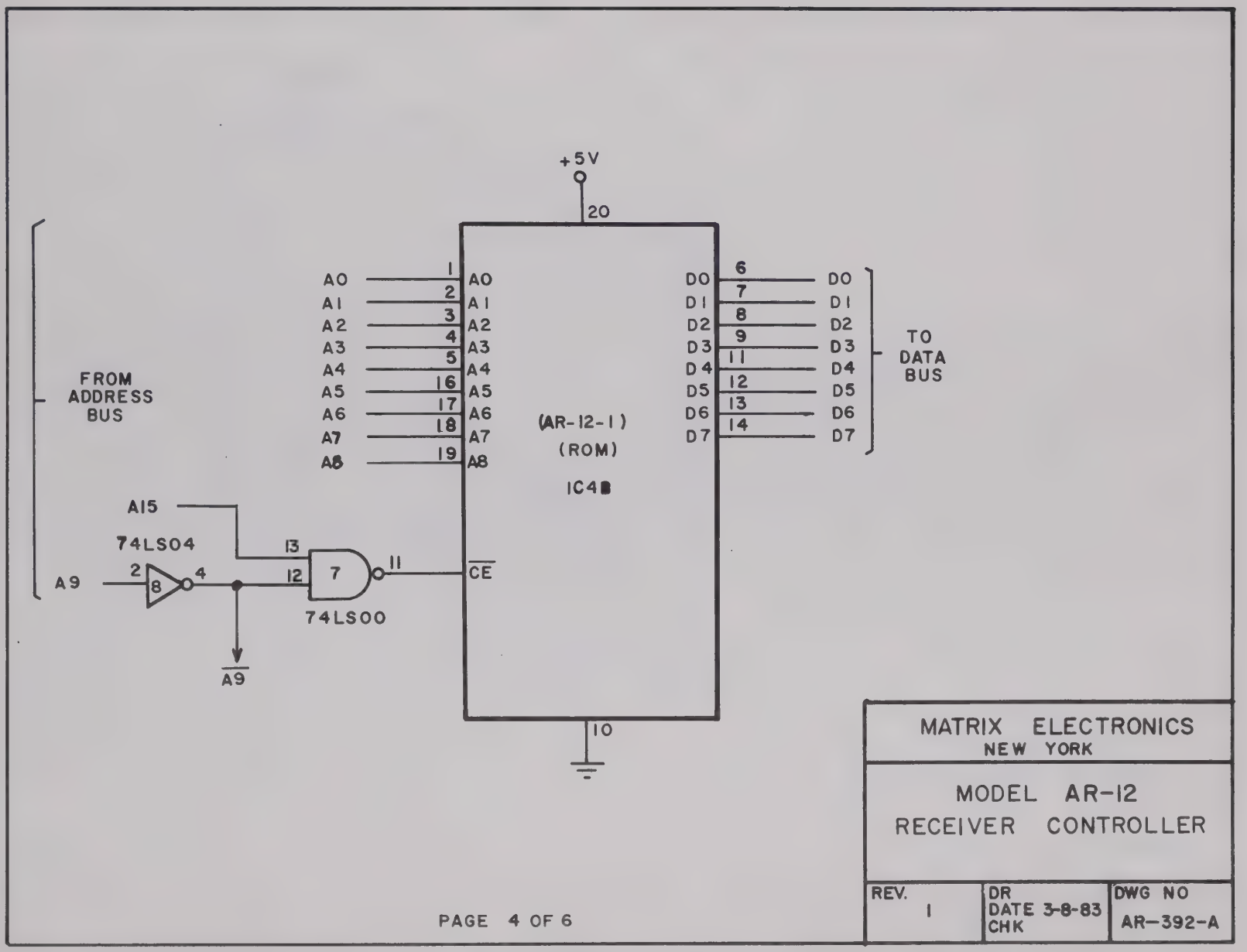


FIGURE 1-10(CONT.)

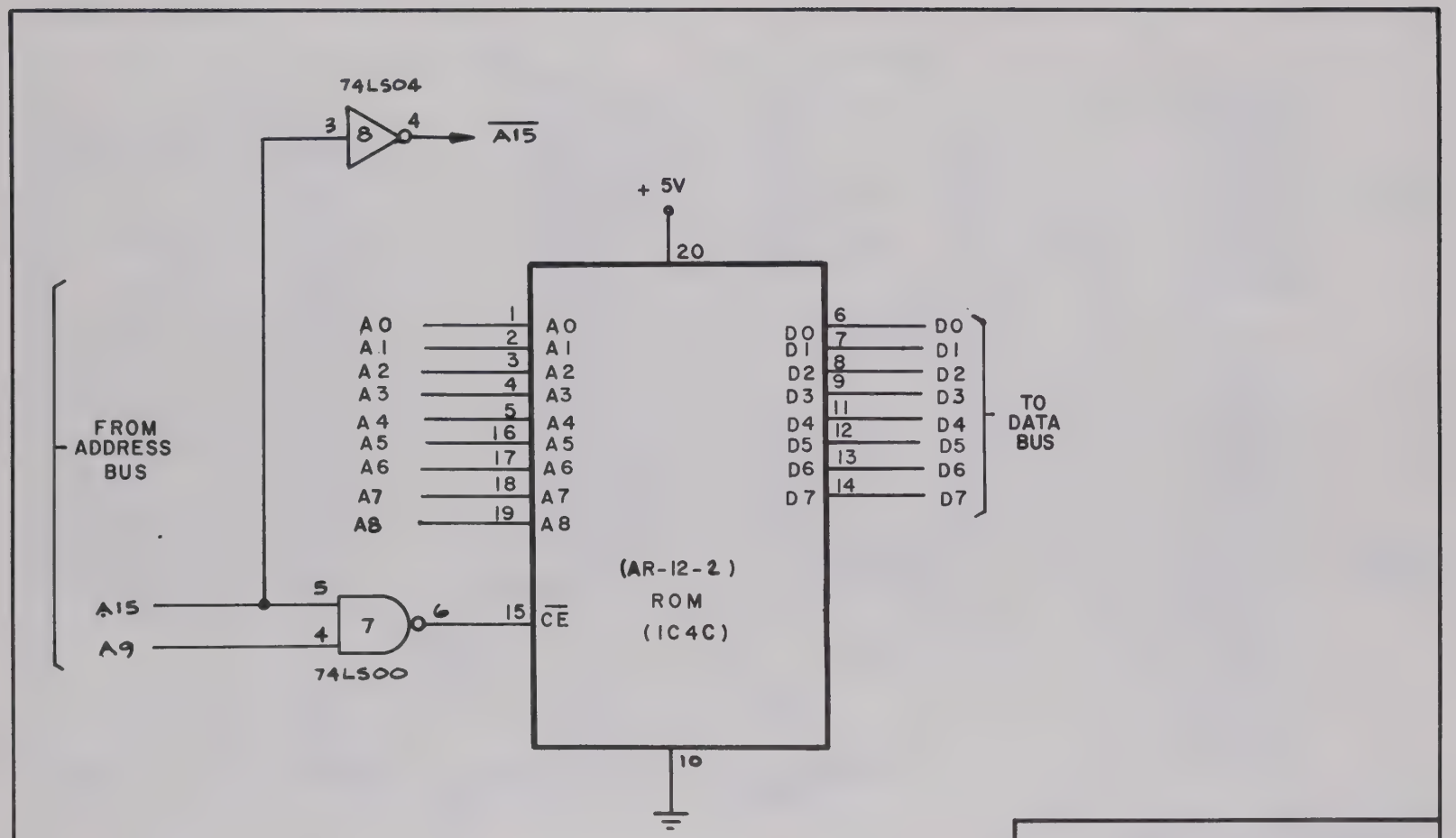
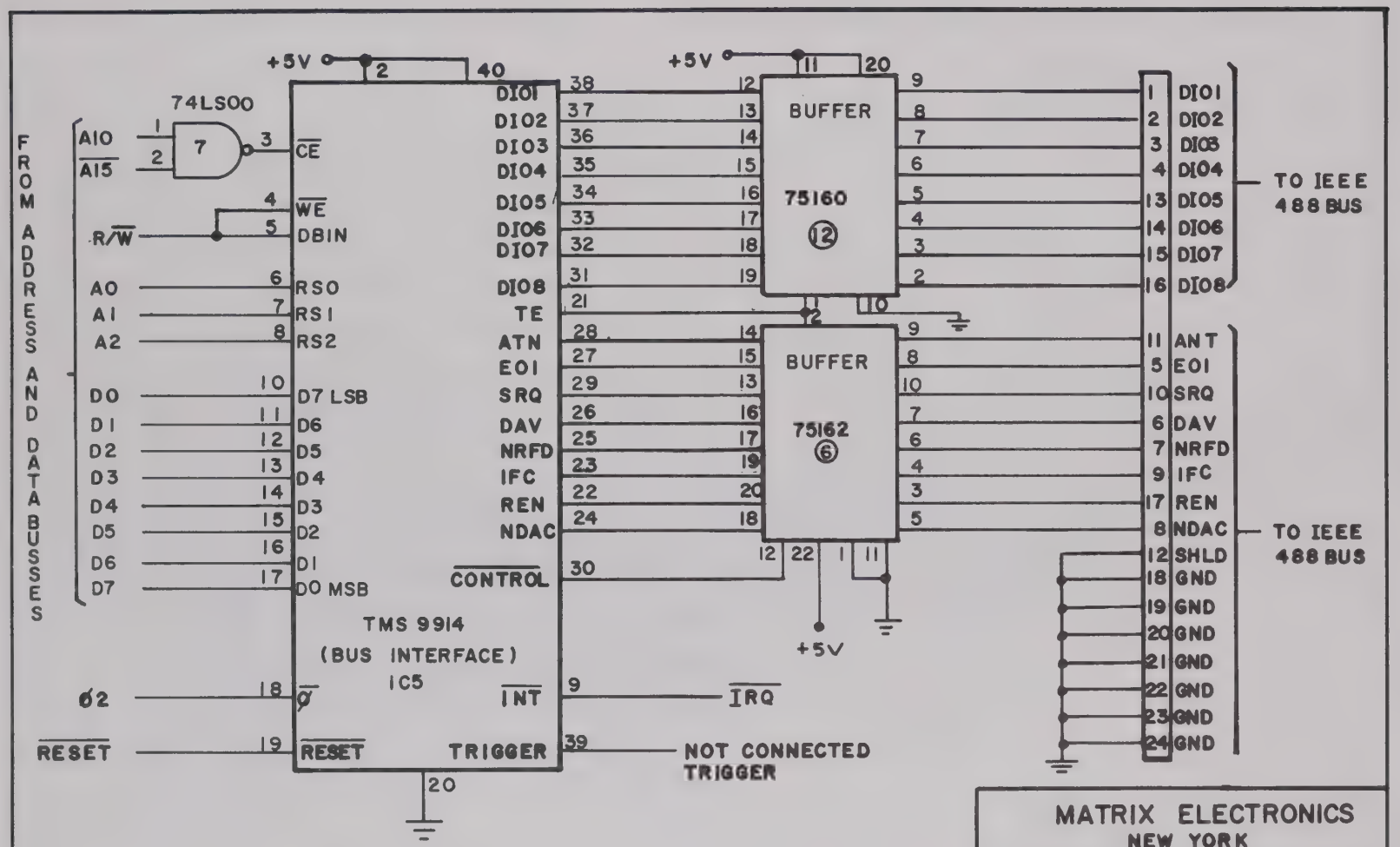


FIGURE 1-10 (CONT.)



MATRIX ELECTRONICS
NEW YORK

MODEL AR-12
RECEIVER CONTROLLER

REV	DR	DWG NO.
1	DATE 3-8-83 CHK.	AR-376-A

FIGURE 1-10(CONT.)

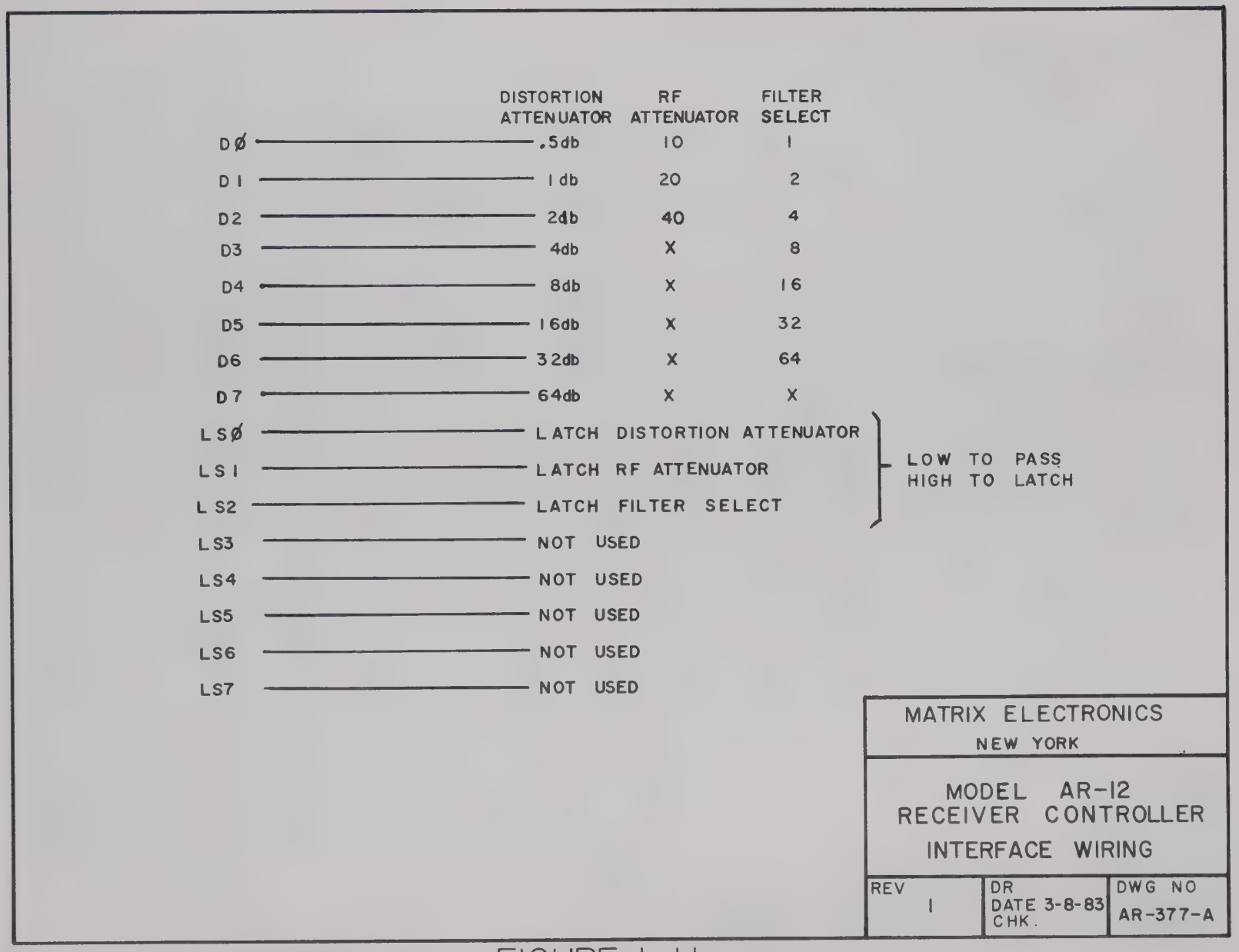

DISTORTION ATTENUATOR
RF ATTENUATOR
FILTER SELECT
DØ .5db 10 1
D1 1db 20 2
D2 2db 40 4
D3 4db X 8
D4 8db X 16
D5 16db X 32
D6 32db X 64
D7 64db X X
LSØ LATCH DISTORTION ATTENUATOR
LS1 LATCH RF ATTENUATOR
LS2 LATCH FILTER SELECT
LOW TO PASS
HIGH TO LATCH
LS3 NOT USED
LS4 NOT USED
LS5 NOT USED
LS6 NOT USED
LS7 NOT USED
MATRIX ELECTRONICS
NEW YORK
MODEL AR-12
RECEIVER CONTROLLER
INTERFACE WIRING
REV 1
DR
DATE 3-8-83
CHK.
DWG NO
AR-377-A

FIGURE 1-11

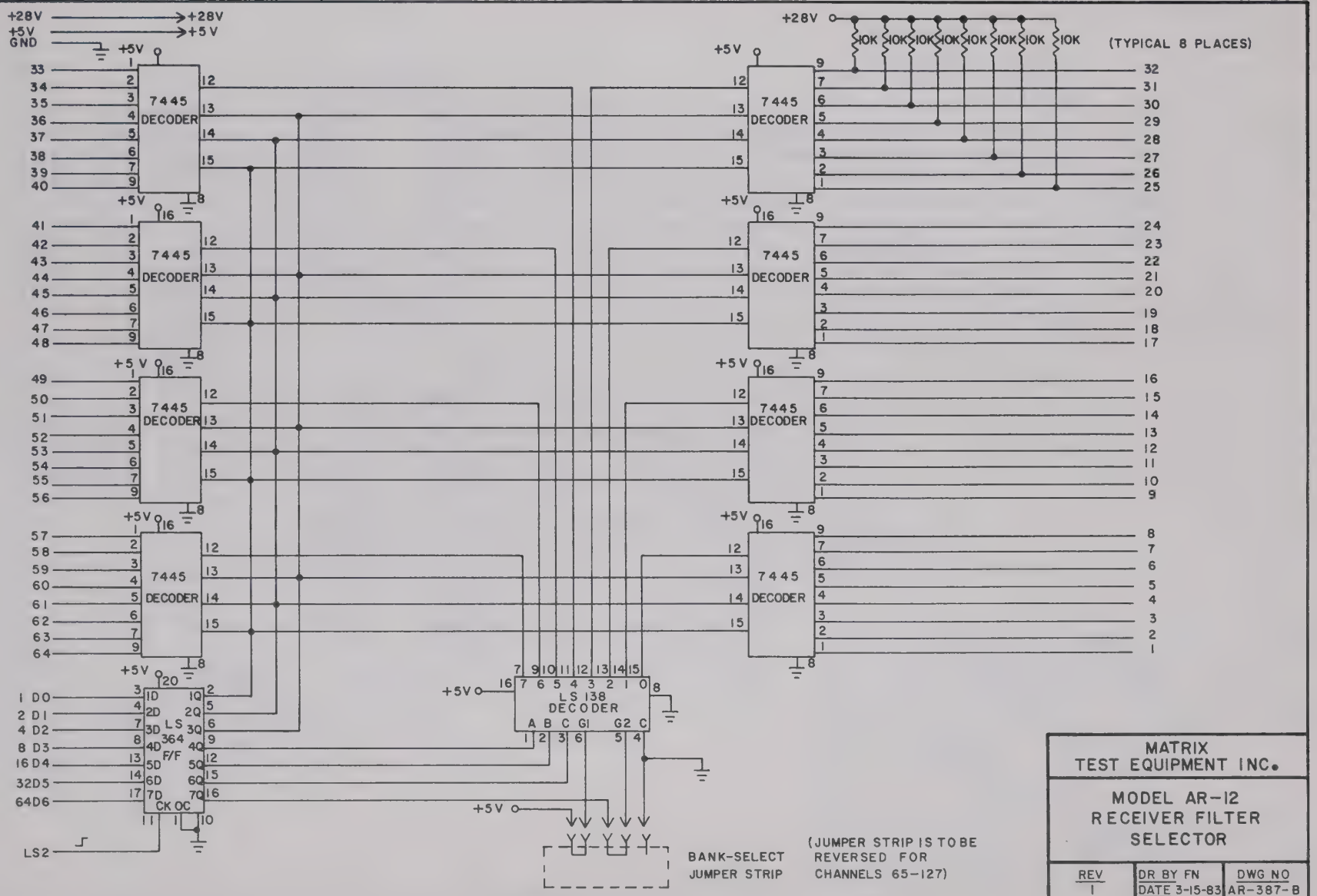

+28V
+28V
+5V
+5V
GND
7445 DECODER
LS 138 DECODER
A B C G1 G2 C
LS 364 F/F
CK OC
1 D0
2 D1
4 D2
8 D3
16 D4
32 D5
64 D6
LS2
10K (TYPICAL 8 PLACES)
BANK-SELECT JUMPER STRIP
(JUMPER STRIP IS TO BE REVERSED FOR CHANNELS 65-127)
MATRIX TEST EQUIPMENT INC.
MODEL AR-12 RECEIVER FILTER SELECTOR
REV 1
DR BY FN
DATE 3-15-83
DWG NO AR-387-B

FIGURE 1-12

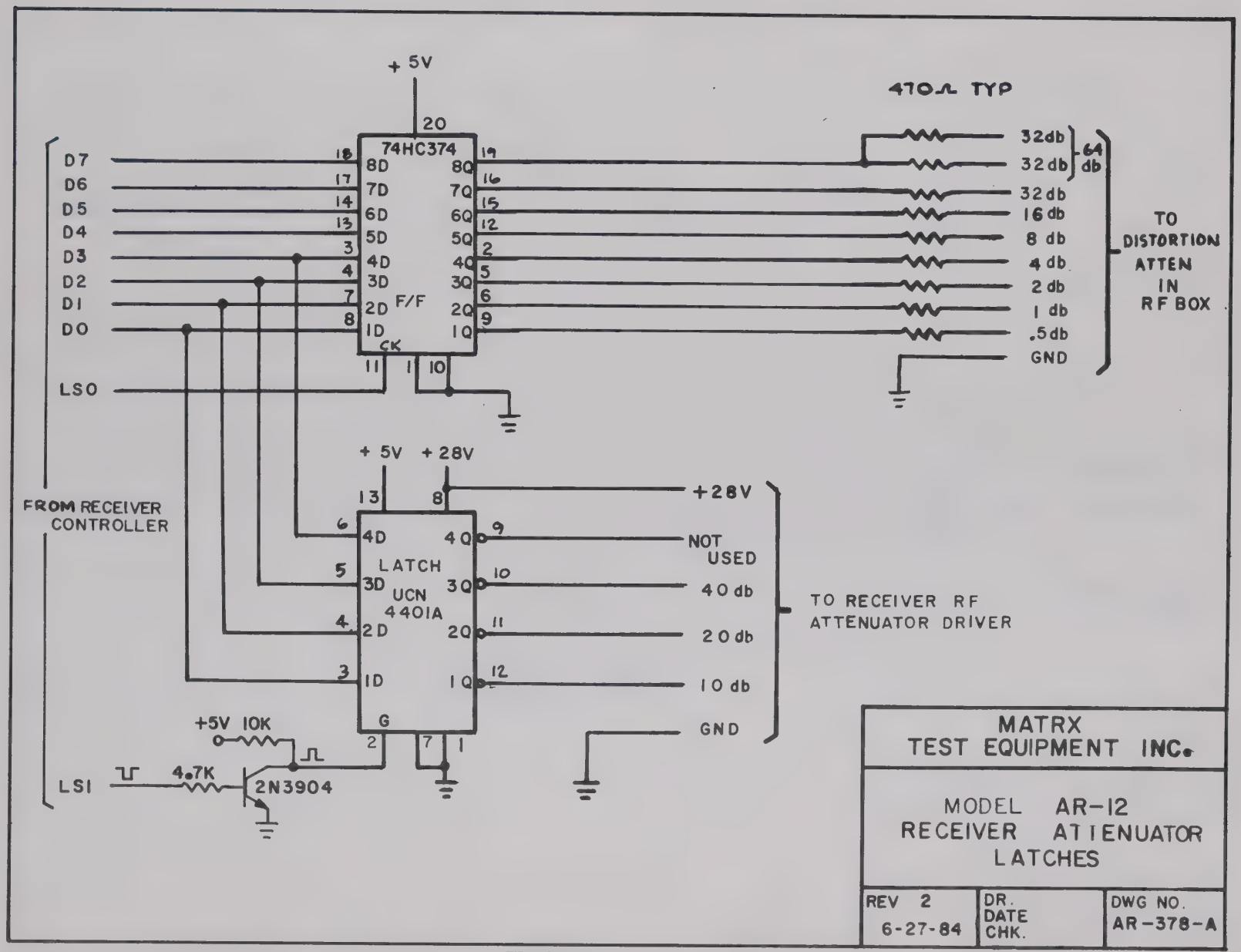
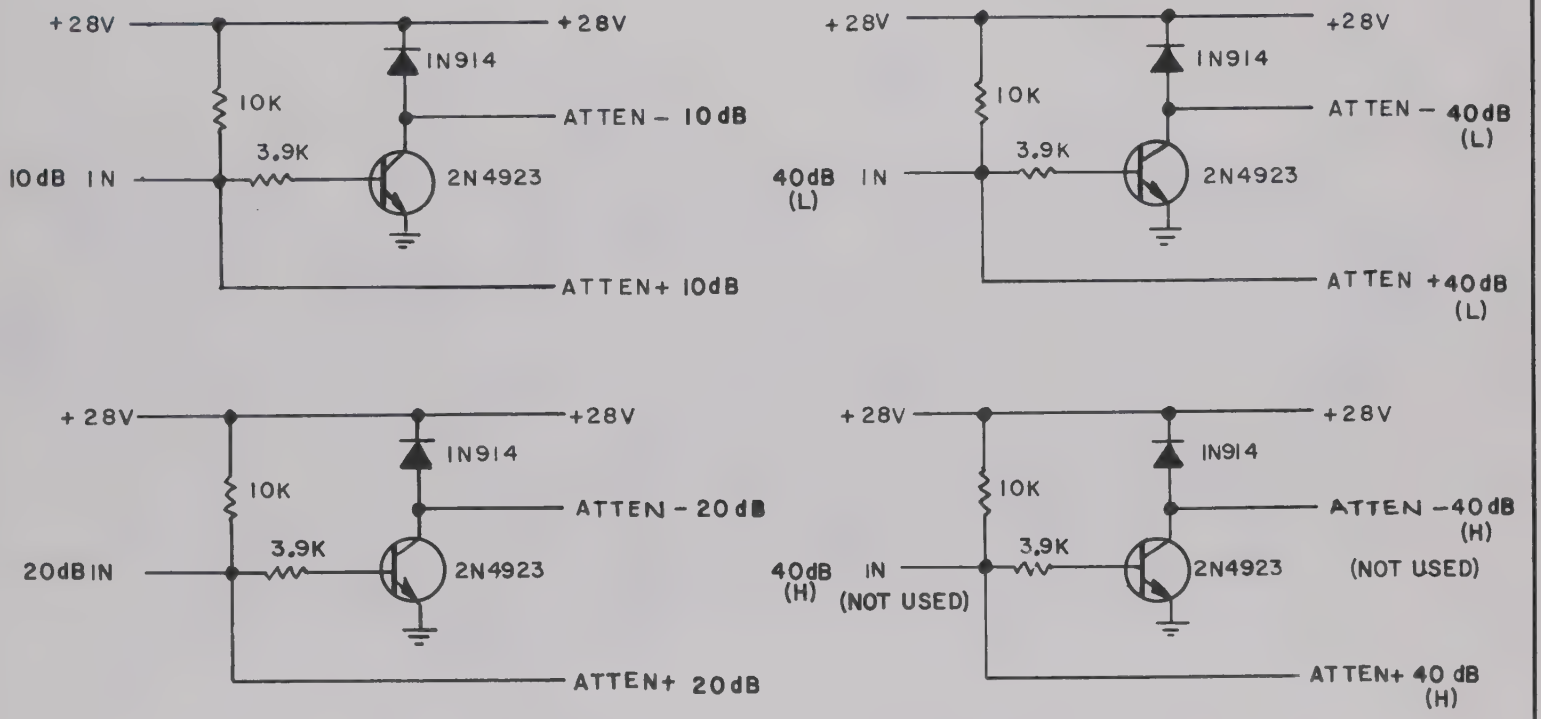

+ 5V
20
74HC374
F/F
D7
D6
D5
D4
D3
D2
D1
D0
8D
7D
6D
5D
4D
3D
2D
1D
CK
8Q
7Q
6Q
5Q
4Q
3Q
2Q
1Q
LSO
470Ω TYP
32db
32db
64 db
32db
16db
8 db
4 db
2 db
1 db
.5db
GND
TO DISTORTION ATTEN IN RF BOX
+ 5V
+ 28V
FROM RECEIVER CONTROLLER
LATCH
UCN 4401A
+28V
NOT USED
40db
20db
10db
GND
TO RECEIVER RF ATTENUATOR DRIVER
+5V 10K
4.7K
2N3904
LSI
MATRX TEST EQUIPMENT INC.
MODEL AR-12
RECEIVER ATTENUATOR LATCHES
REV 2
6-27-84
DR.
DATE
CHK.
DWG NO.
AR-378-A

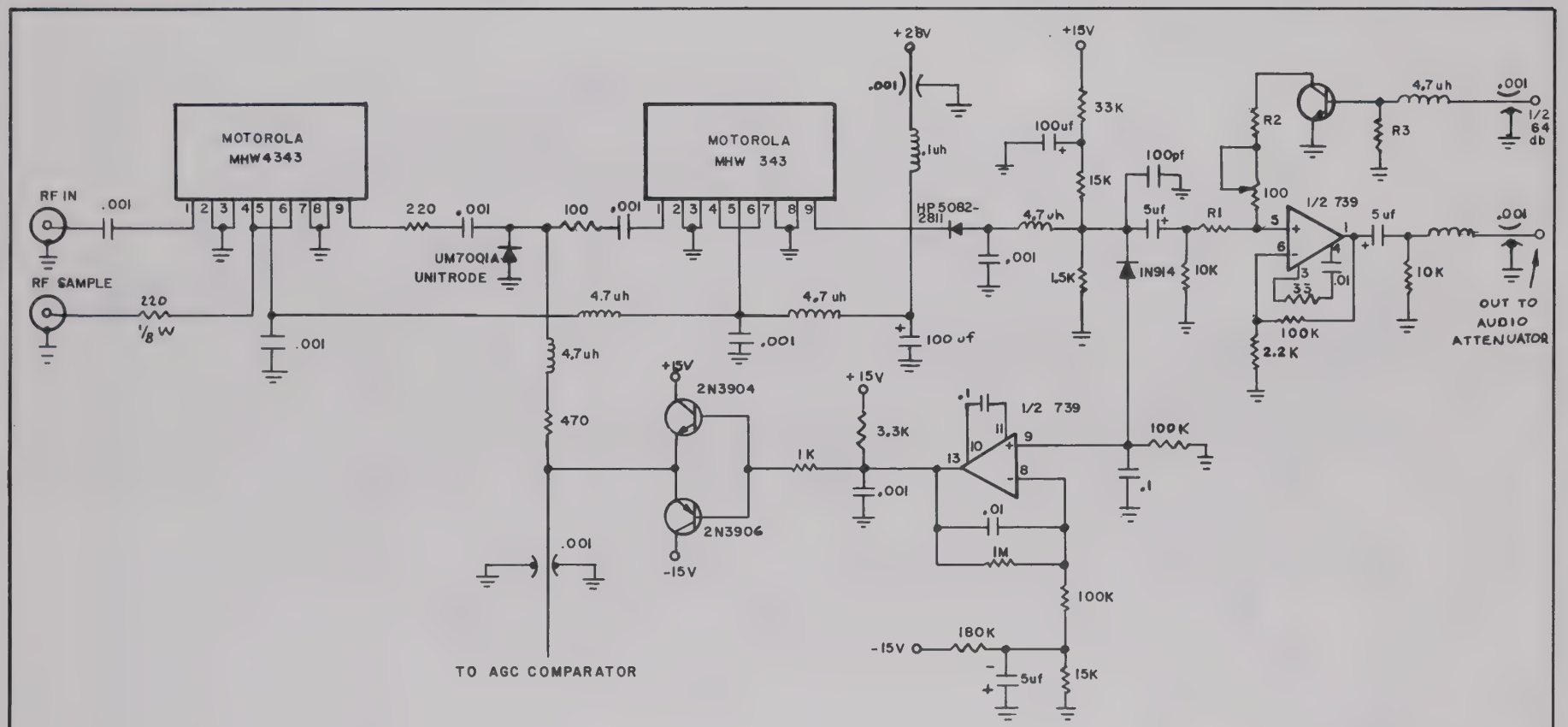
FIGURE 1-13A



ALL INPUTS FROM RECEIVER ATTENUATOR LATCHES
ALL OUTPUTS TO 0-70dB RF ATTENUATOR

MATRIX ELECTRONICS NEW YORK		
MODEL AR-12 RECEIVER RF ATTENUATOR DRIVERS		
REV 1	DR DATE 3-8-83 CHK.	DWG NO. AR-379-A

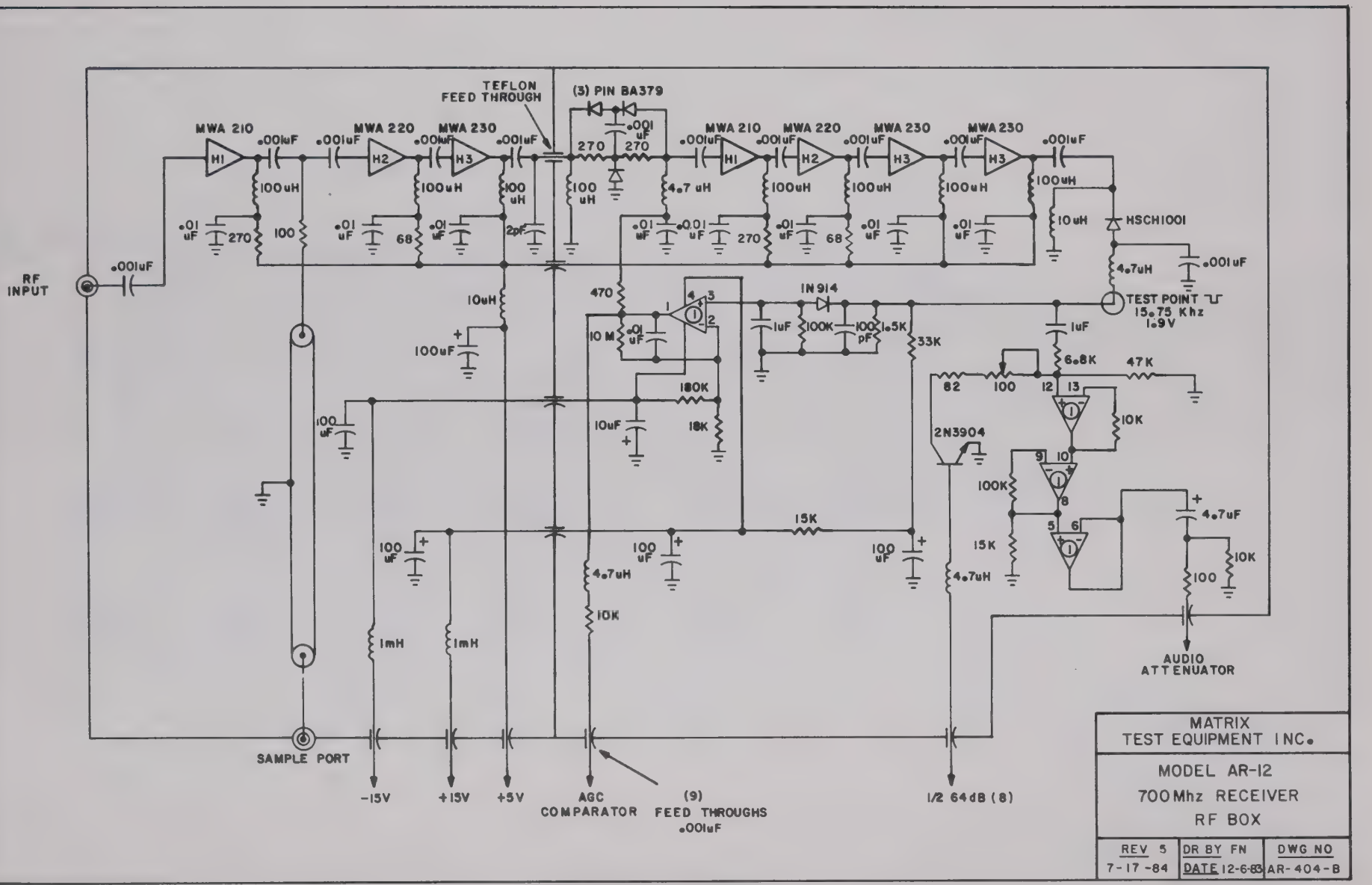
FIGURE 1-13B



FOR UNITS MANUFACTURED PRIOR TO 1982

MATRIX ELECTRONICS NEW YORK		
MODEL AR-12 RECEIVER RF BOX		
REV 1	DR DATE 3-9-83 CHK.	DWG NO. AR-385-B

FIGURE 1-14A



MATRIX
TEST EQUIPMENT INC.

MODEL AR-12
700Mhz RECEIVER
RF BOX

REV 5	DR BY FN	DWG NO
7-17-84	DATE 12-6-83	AR-404-B

FIGURE 1-14A(CONT.)

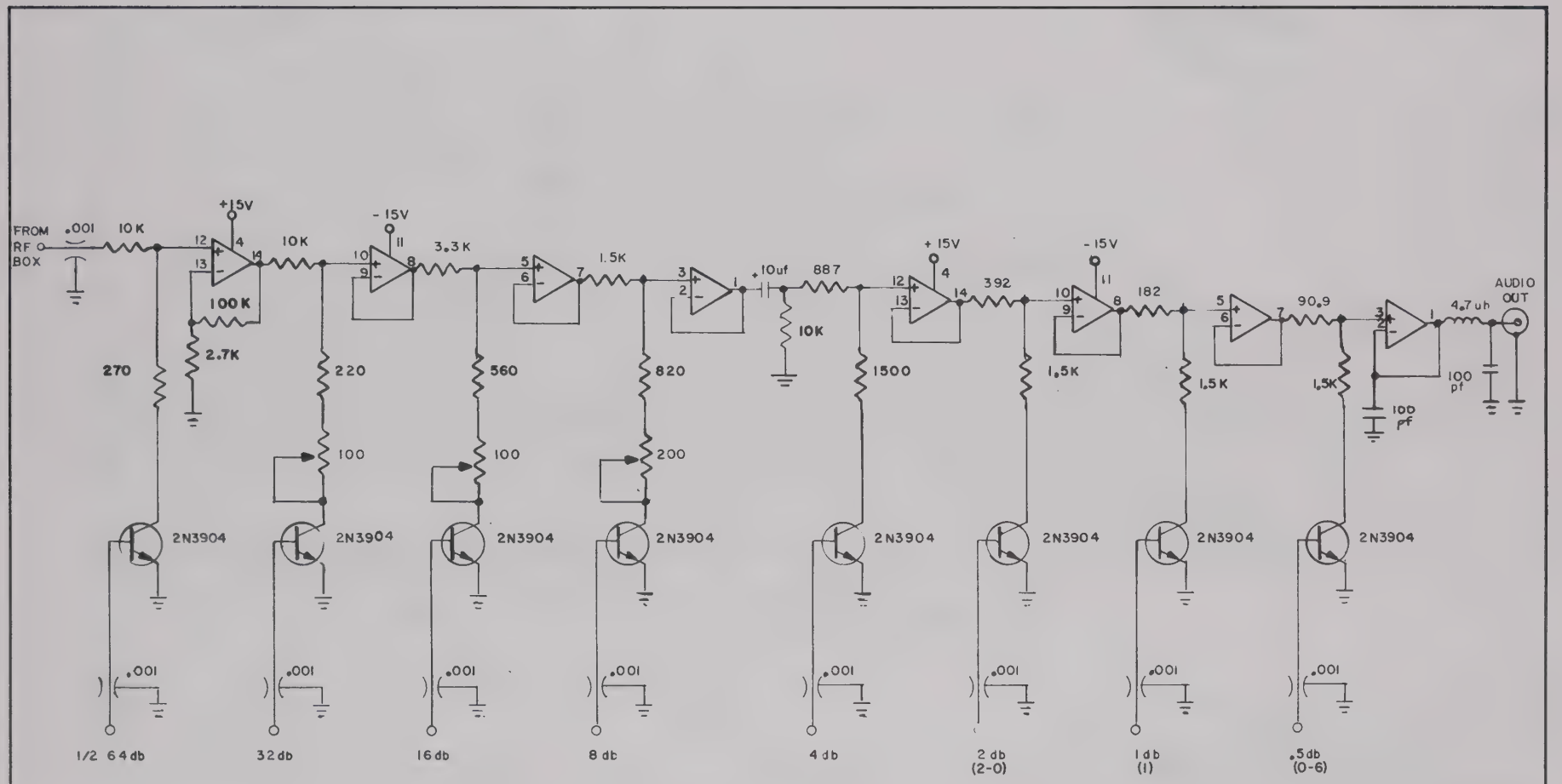
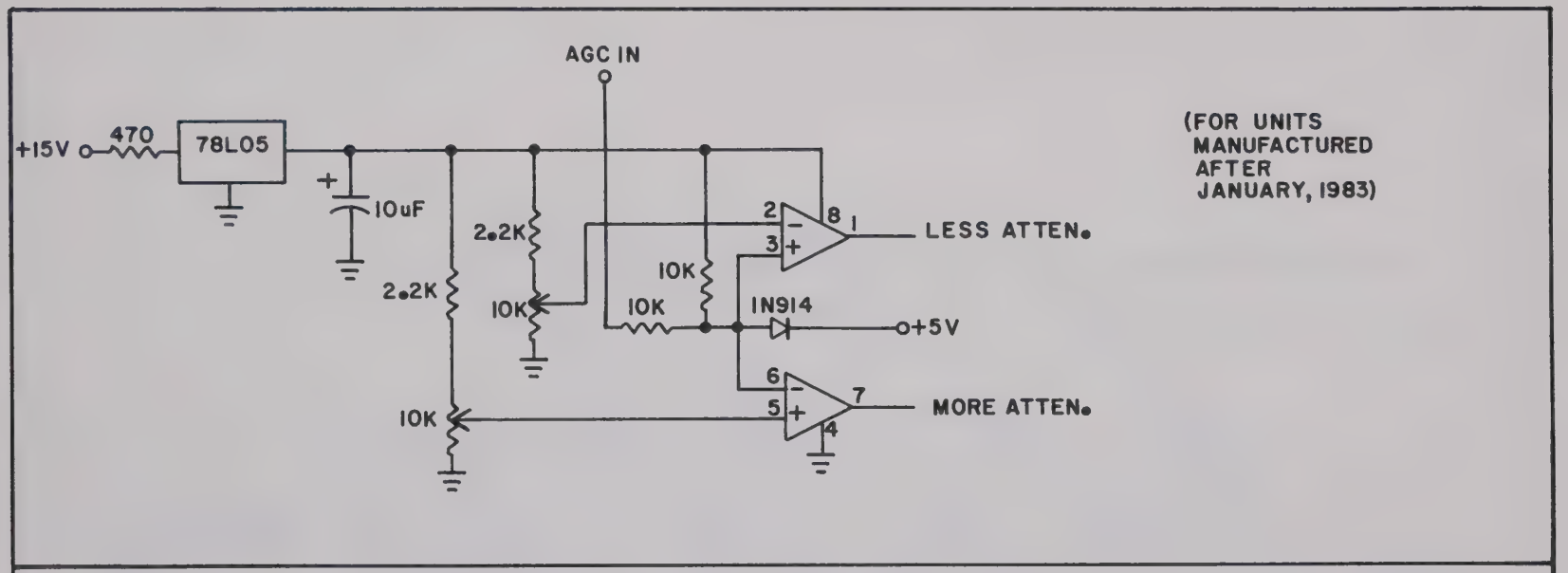
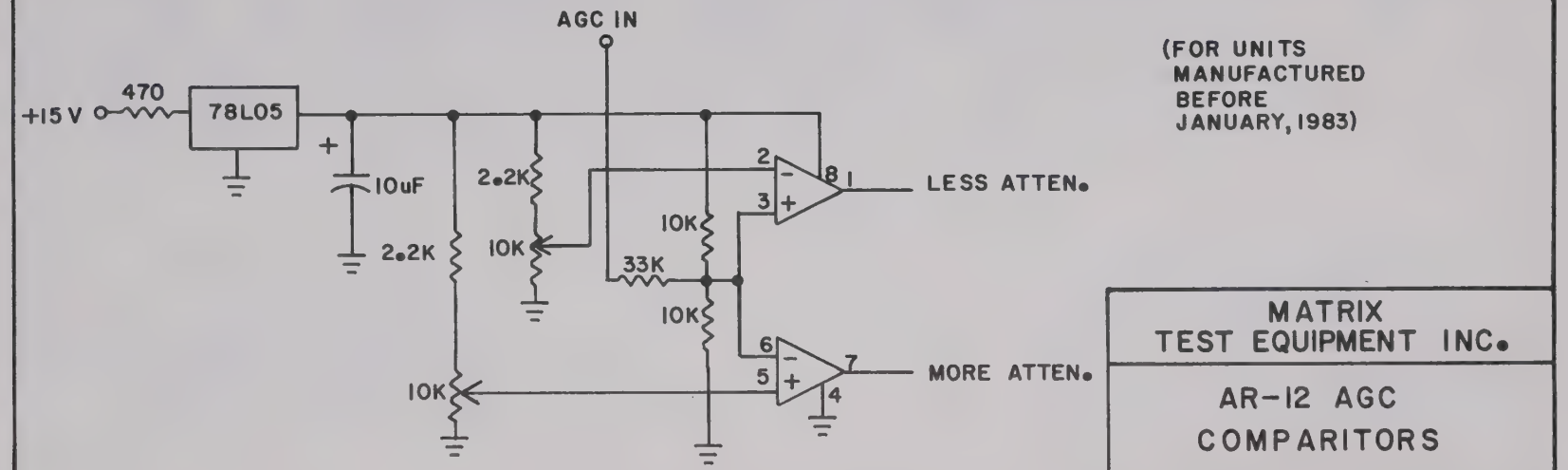

FROM RF BOX
.001
10K
+15V
- 15V
100K
2.7K
270
10K
220
100
2N3904
.001
1/2 64db
32db
3.3K
560
16db
1.5K
820
200
8db
10uf
10K
887
1500
4db
+ 15V
392
1.5K
2 db (2-0)
- 15V
182
1.5K
1 db (1)
90.9
1.5K
.5db (0-6)
4.7uh
100 pf
100 pf
AUDIO OUT
MATRIX ELECTRONICS
NEW YORK
MODEL AR-12 RECEIVER
AUDIO ATTENUATOR
REV. 1
DR.
DATE 3-14-83
CHK.
DWG. NO. AR-382-B

FIGURE 1-14B





MATRIX TEST EQUIPMENT INC.		
AR-12 AGC COMPARITORS (MOUNTED ON RF BOX)		
REV 2 6-27-84	DR BY FN DATE 3-10-83	DWG NO AR-381-A

FIGURE 1-14C

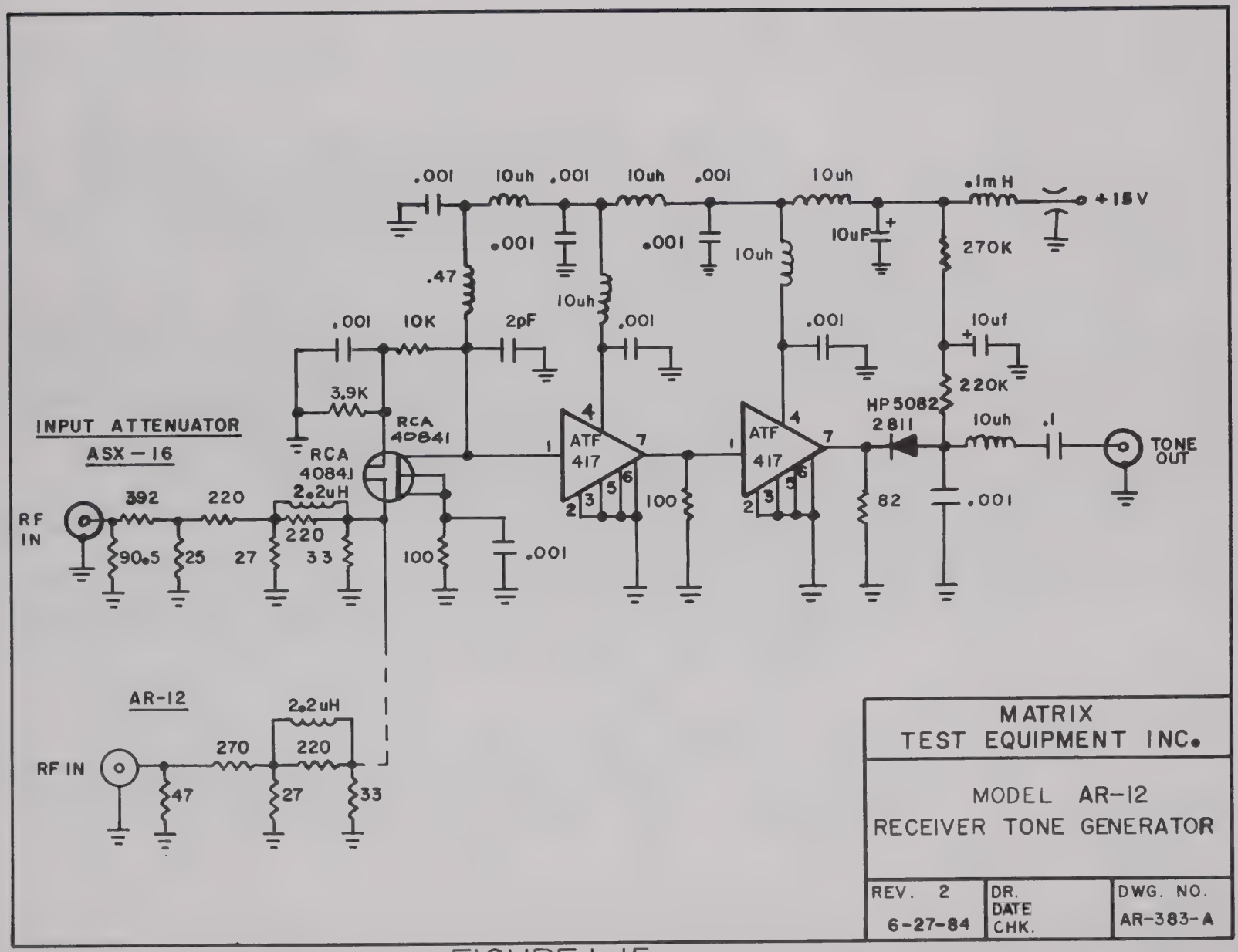

.001
10uh
.001
10uh
.001
10uh
.1mH
+15V
.001
.001
10uF
270K
.47
10uh
10uh
.001
10K
2pF
.001
.001
10uf
3.9K
220K
HP5082
2811
INPUT ATTENUATOR
ASX-16
RCA
40841
RCA
40841
ATF
417
ATF
417
10uh
.1
TONE
OUT
392
220
2.2uH
RF
IN
90.5
25
27
220
33
100
.001
100
82
.001
AR-12
2.2uH
270
220
RF IN
47
27
33
MATRIX
TEST EQUIPMENT INC.
MODEL AR-12
RECEIVER TONE GENERATOR
REV. 2
6-27-84
DR.
DATE
CHK.
DWG. NO.
AR-383-A

FIGURE 1-15

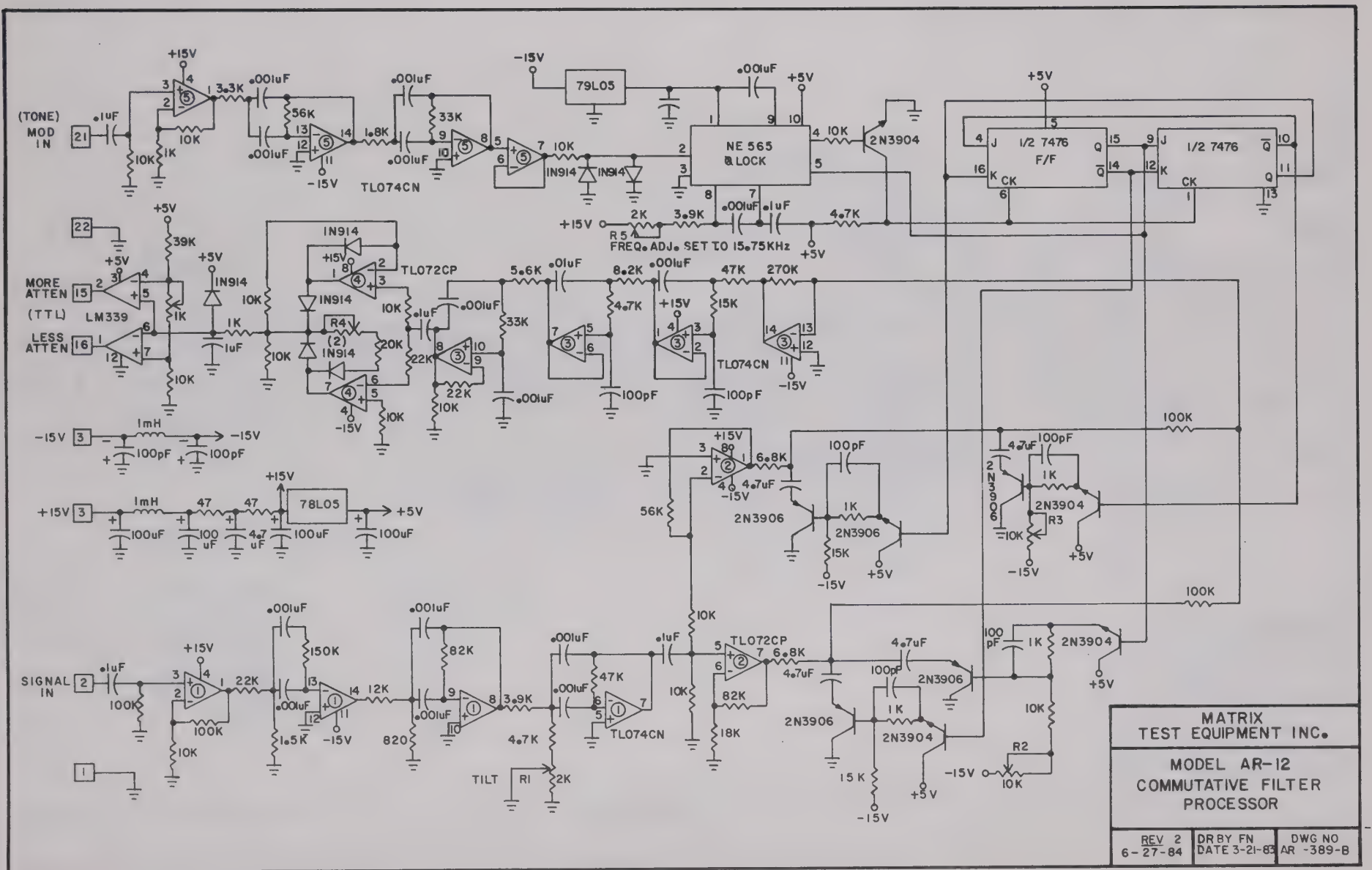
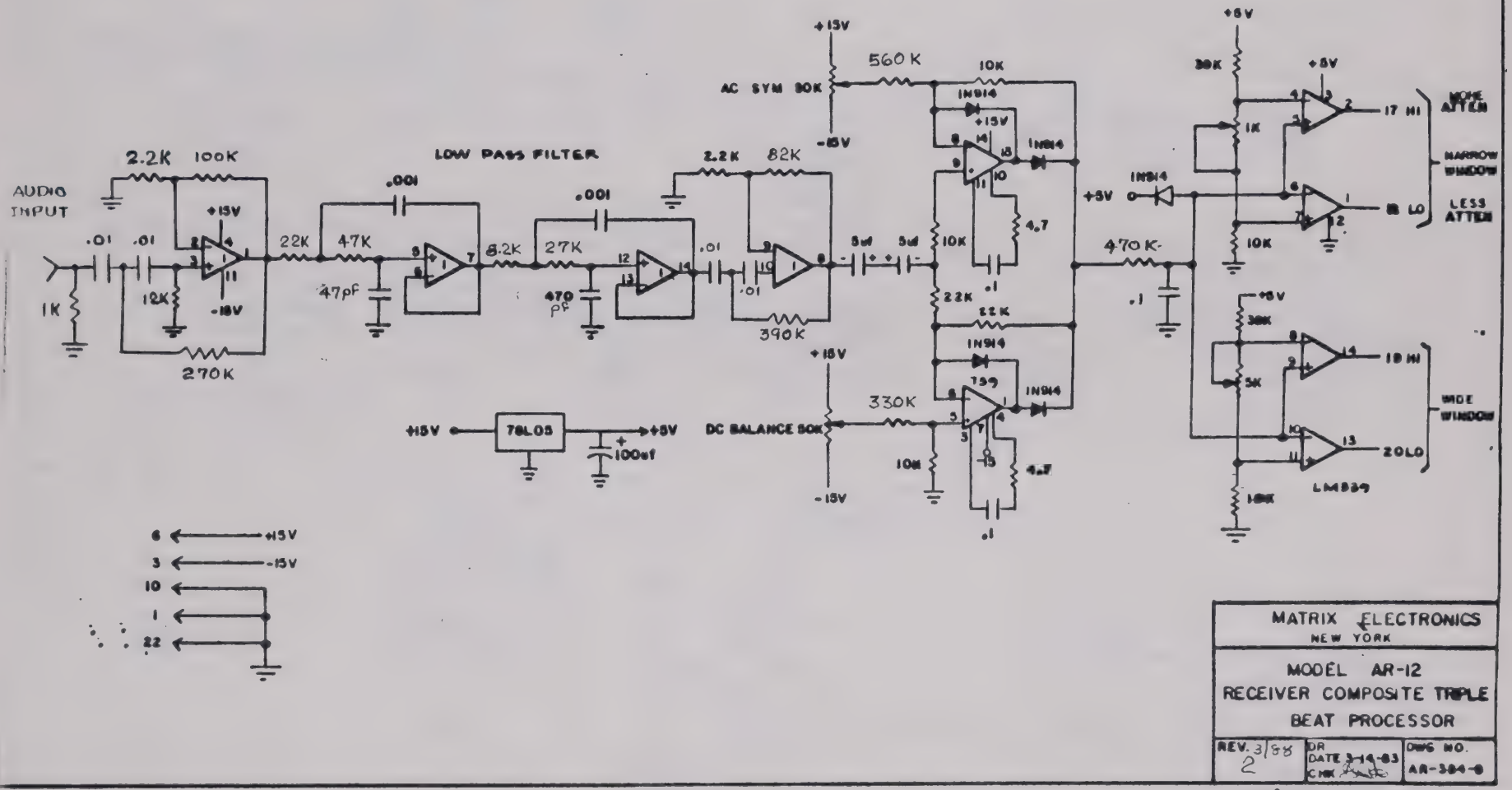

(TONE) MOD IN
MORE ATTEN (TTL)
LESS ATTEN
LM339
SIGNAL IN
TILT
R1
R4
R5
FREQ. ADJ. SET TO 15.75KHz
TL074CN
TL072CP
NE 565 PLL LOCK
79L05
78L05
1/2 7476 F/F
2N3904
2N3906
IN914
R2
R3
MATRIX
TEST EQUIPMENT INC.
MODEL AR-12
COMMUTATIVE FILTER
PROCESSOR
REV 2
6-27-84
DR BY FN
DATE 3-21-83
DWG NO
AR -389-B

FIGURE 1-16



MATRIX ELECTRONICS NEW YORK		
MODEL AR-12 RECEIVER COMPOSITE TRIPLE BEAT PROCESSOR		
REV. 3/88 2	DR DATE 3-14-83 CHK	DWG NO. AR-384-B

FIGURE 1-17

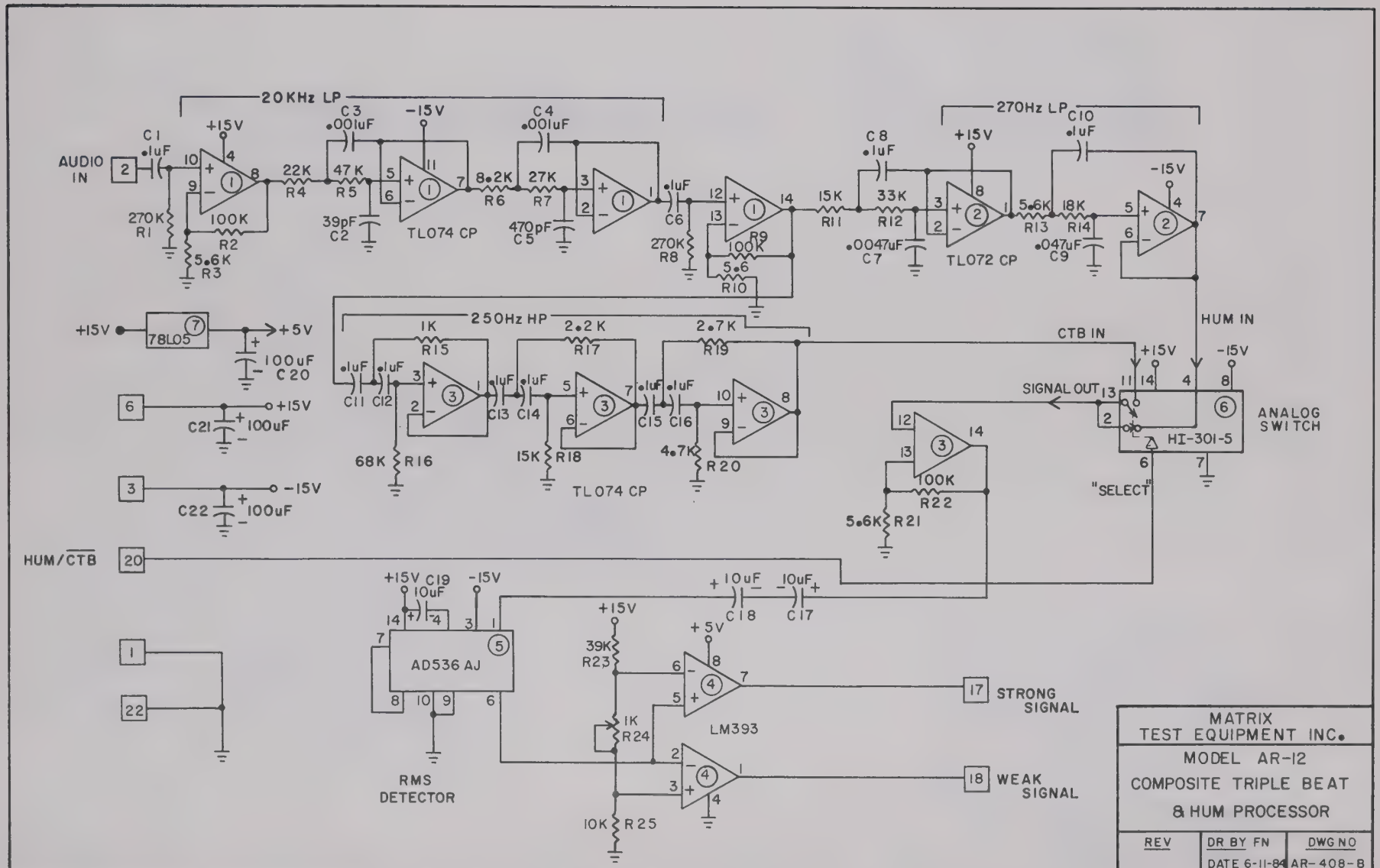
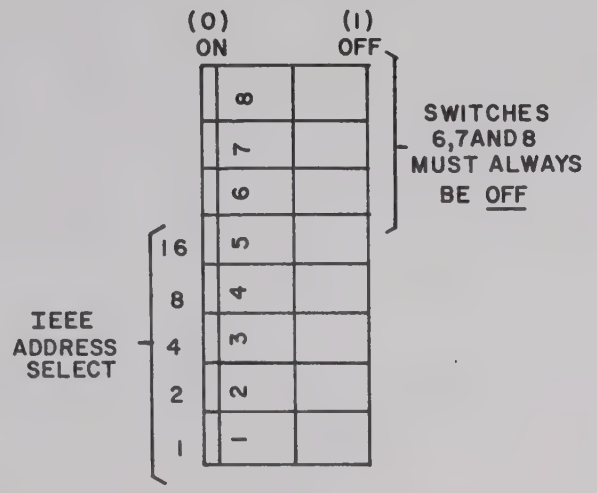

20KHz LP
270Hz LP
250Hz HP
AUDIO IN
+15V
-15V
C1 .1uF
C3 .001uF
C4 .001uF
C8 .1uF
C10 .1uF
R1 270K
R2 100K
R3 5.6K
R4 22K
R5 47K
R6 8.2K
R7 27K
R8 270K
R9 100K
R10 5.6
R11 15K
R12 33K
R13 5.6K
R14 18K
C2 39pF
C5 470pF
C6 .1uF
C7 .0047uF
C9 .047uF
TL074 CP
TL072 CP
+15V
78L05
+5V
100uF C20
6
+15V
C21 100uF
3
-15V
C22 100uF
1K R15
2.2K R17
2.7K R19
C11 .1uF
C12 .1uF
C13 .1uF
C14 .1uF
C15 .1uF
C16 .1uF
68K R16
15K R18
4.7K R20
CTB IN
HUM IN
SIGNAL OUT
HI-301-5
ANALOG SWITCH
"SELECT"
100K R22
5.6K R21
HUM/CTB
20
+15V C19 10uF
-15V
+10uF C18
-10uF C17
AD536 AJ
RMS DETECTOR
39K R23
1K R24
10K R25
+5V
LM393
17
STRONG SIGNAL
18
WEAK SIGNAL
1
22
MATRIX
TEST EQUIPMENT INC.
MODEL AR-12
COMPOSITE TRIPLE BEAT
& HUM PROCESSOR
REV
DR BY FN
DATE 6-11-84
DWG NO
AR-408-B

FIGURE 1-17A

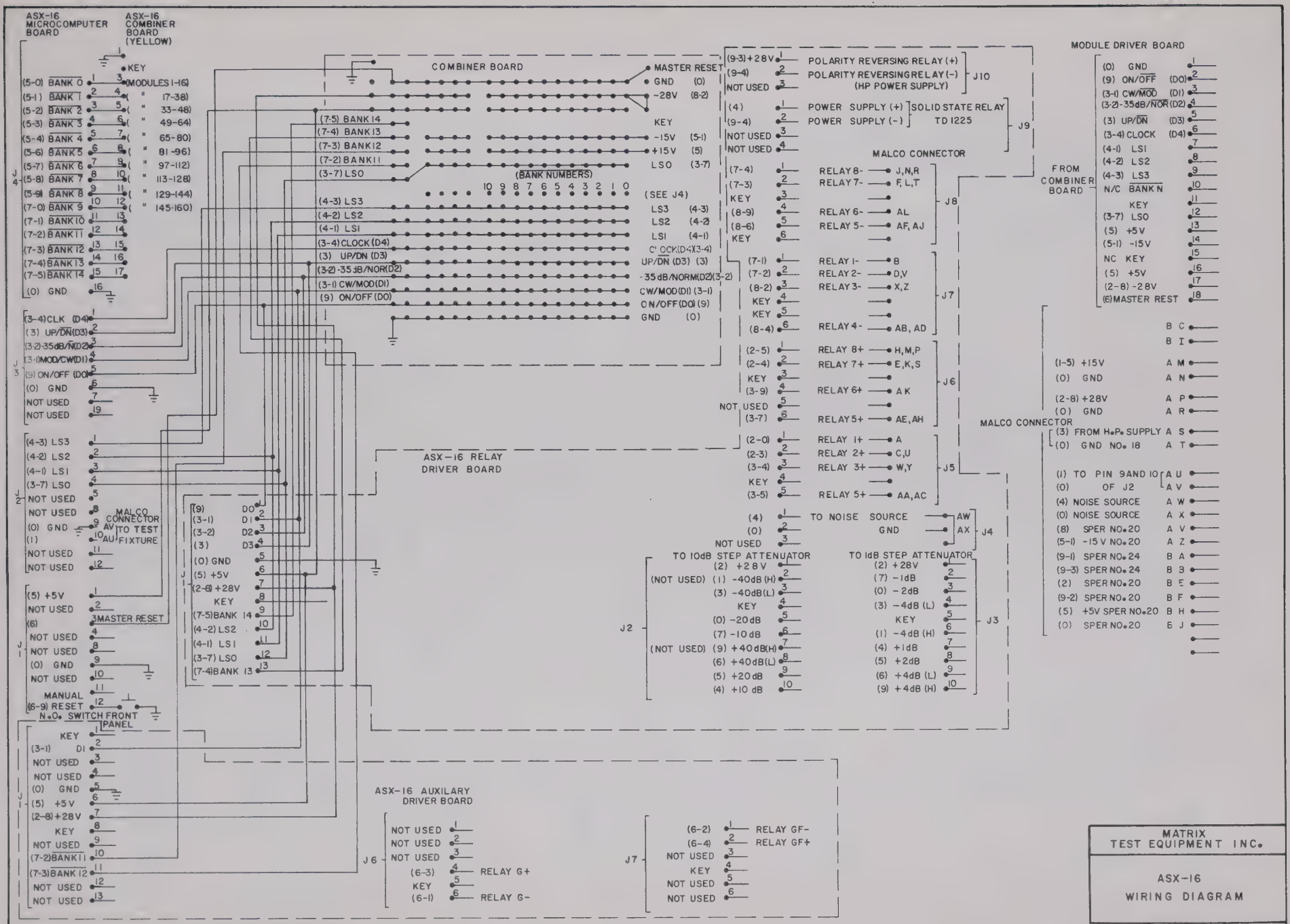
NOTE: IF A SWITCH IS ON, ITS NUMBERED END IS DOWN
IF A SWITCH IS OFF, ITS UNNUMBERED END IS DOWN
ON = LOGIC 0
OFF = LOGIC 1

IEEE ADDRESS	16	8	4	2	1
23(RECEIVER)	OFF	ON	OFF	OFF	OFF
24(GENERATOR)	OFF	OFF	ON	ON	ON



MATRIX TEST EQUIPMENT INC.		
DIP SWITCH SETTINGS FOR ASX-16, AR-12 AND DTS MICROCONTROLLER BOARDS		
REV	DR BY FN DATE 4-5-83	DWG NO 393-A

FIGURE 1-19



MATRIX TEST EQUIPMENT INC.		
ASX-16 WIRING DIAGRAM		
REV 1	DR BY FN DATE 4-15-83	DWG NO ASX-397-C

FIGURE 1-20

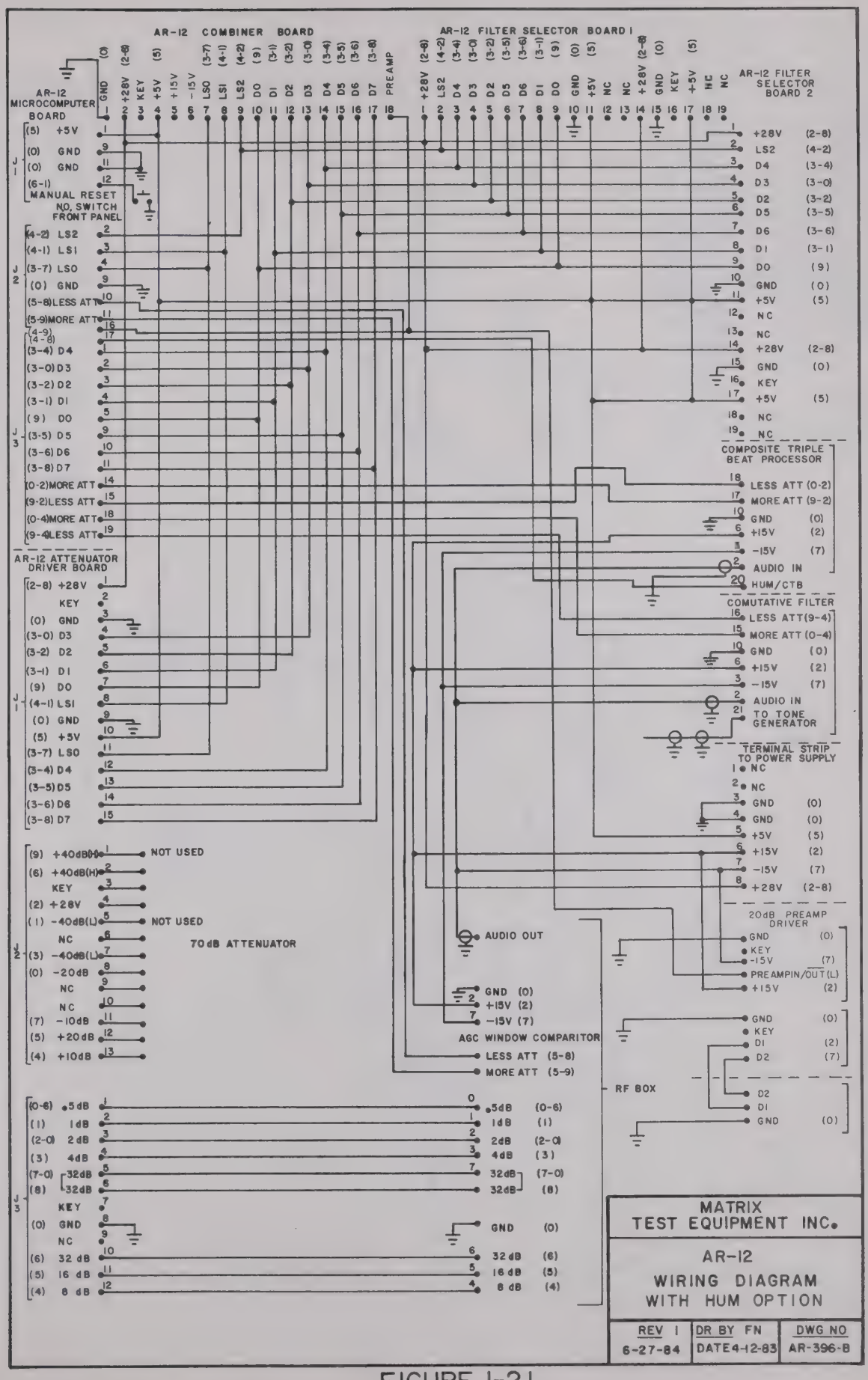

AR-12 COMBINER BOARD
AR-12 FILTER SELECTOR BOARD 1
AR-12 FILTER SELECTOR BOARD 2
AR-12 MICROCOMPUTER BOARD
MANUAL RESET NO. SWITCH FRONT PANEL
AR-12 ATTENUATOR DRIVER BOARD
COMPOSITE TRIPLE BEAT PROCESSOR
COMUTATIVE FILTER
TERMINAL STRIP TO POWER SUPPLY
20dB PREAMP DRIVER
70dB ATTENUATOR
AUDIO OUT
AGC WINDOW COMPARITOR
RF BOX
MATRIX TEST EQUIPMENT INC.
AR-12
WIRING DIAGRAM
WITH HUM OPTION
REV 1 6-27-84
DR BY FN DATE 4-12-83
DWG NO AR-396-B

FIGURE 1-21

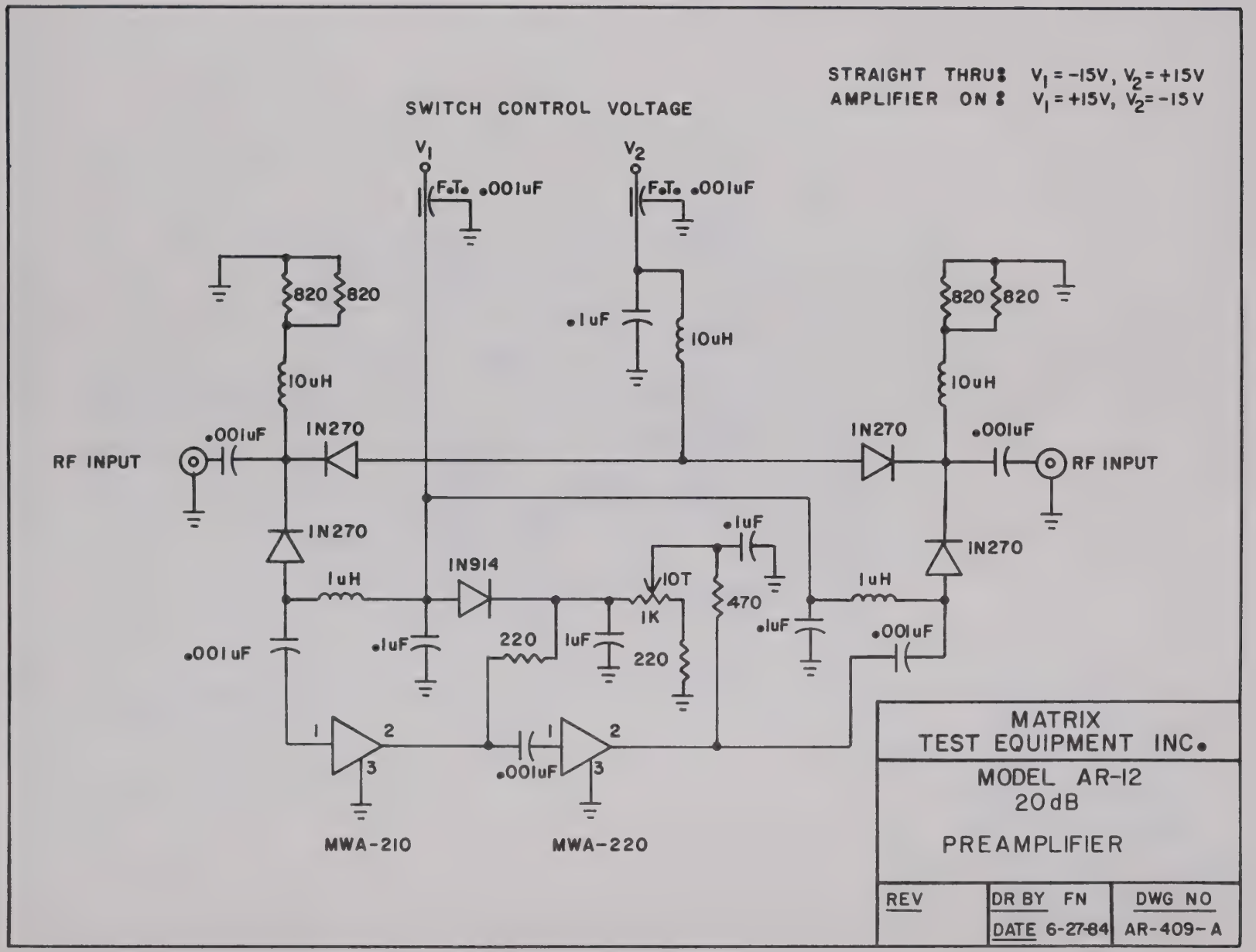

STRAIGHT THRU: V_1 = -15V, V_2 = +15V
AMPLIFIER ON: V_1 = +15V, V_2 = -15V
SWITCH CONTROL VOLTAGE
V_1
V_2
F.T. .001uF
F.T. .001uF
820
820
10uH
.1uF
10uH
820
820
10uH
.001uF
IN270
RF INPUT
IN270
.001uF
RF INPUT
IN270
IN270
.1uF
IN914
10T
1K
470
1uH
1uH
.001uF
.1uF
220
1uF
220
.1uF
.001uF
.001uF
1
2
3
1
2
3
MWA-210
MWA-220
MATRIX
TEST EQUIPMENT INC.
MODEL AR-12
20dB
PREAMPLIFIER
REV
DR BY FN
DATE 6-27-84
DWG NO
AR-409-A

FIGURE 1-22A

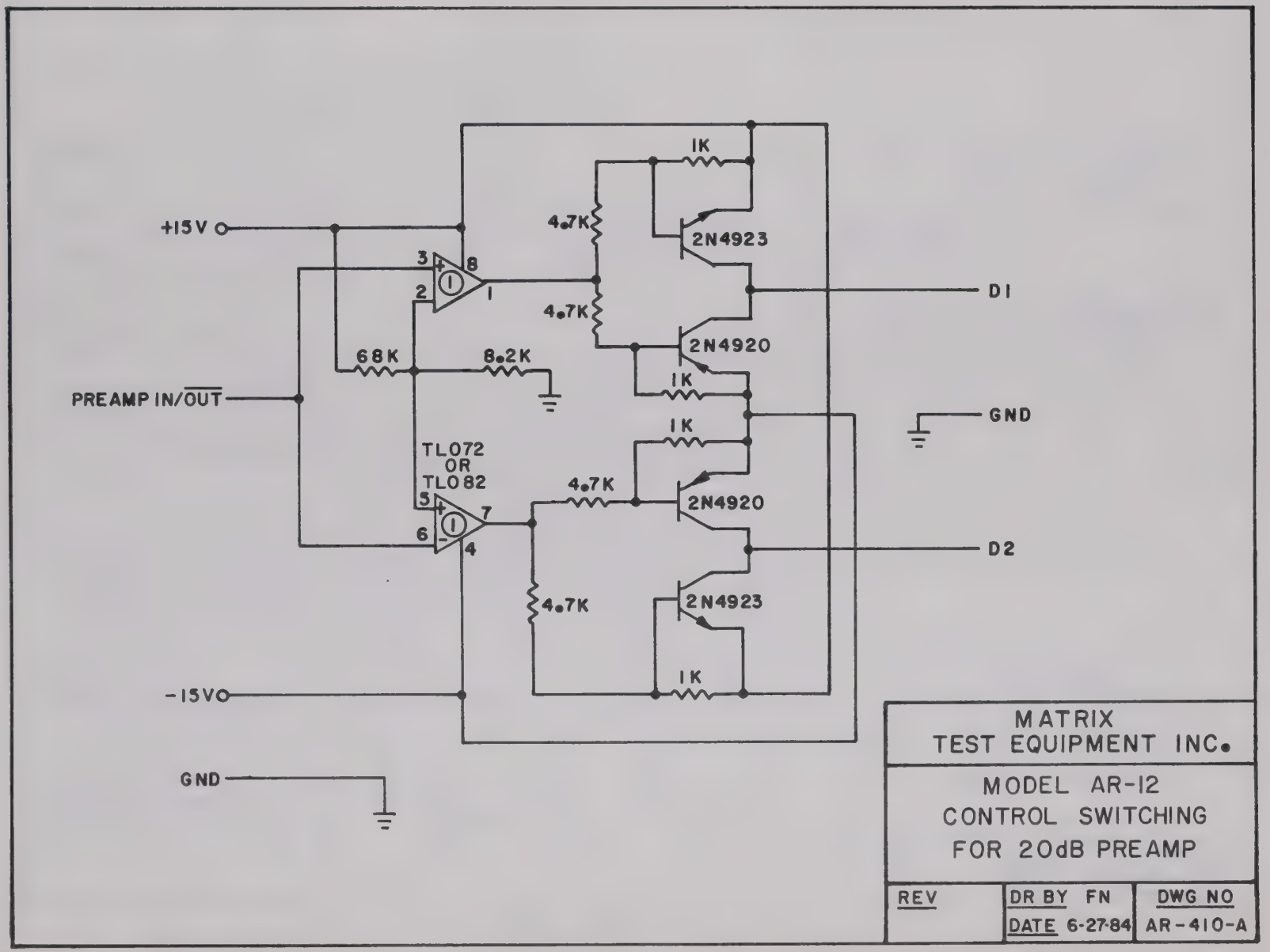

+15V
-15V
GND
GND
PREAMP IN/OUT
TL072
OR
TL082
68K
8.2K
4.7K
4.7K
4.7K
1K
1K
1K
1K
2N4923
2N4920
2N4920
2N4923
D1
D2
MATRIX
TEST EQUIPMENT INC.
MODEL AR-12
CONTROL SWITCHING
FOR 20dB PREAMP
REV
DR BY FN
DATE 6-27-84
DWG NO
AR-410-A

FIGURE 1-22B

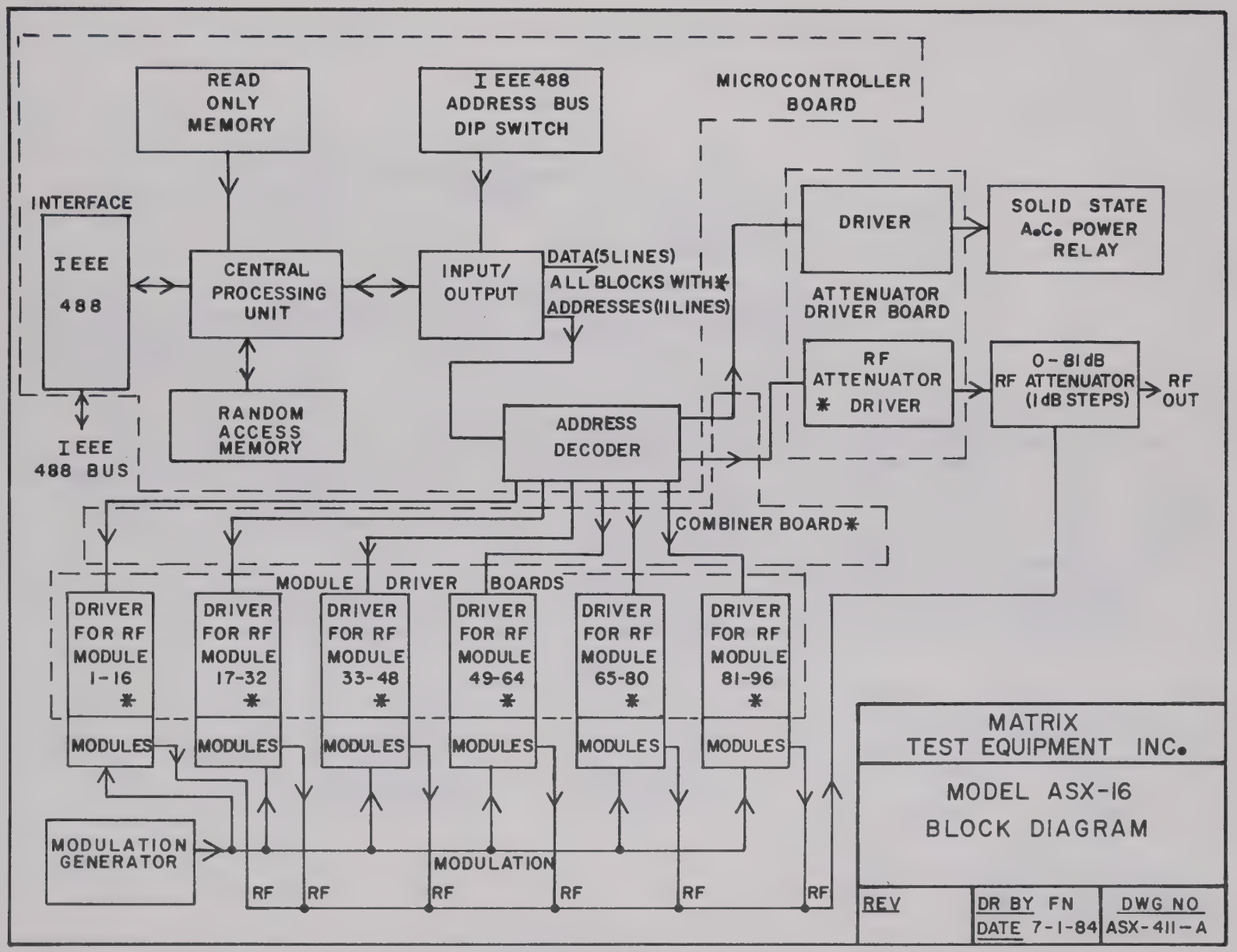

READ ONLY MEMORY
IEEE488 ADDRESS BUS DIP SWITCH
MICROCONTROLLER BOARD
INTERFACE
IEEE 488
CENTRAL PROCESSING UNIT
INPUT/ OUTPUT
DATA(5LINES)
ALL BLOCKS WITH*
ADDRESSES(11LINES)
DRIVER
SOLID STATE A.C. POWER RELAY
ATTENUATOR DRIVER BOARD
RF ATTENUATOR * DRIVER
0-81dB RF ATTENUATOR (1dB STEPS)
RF OUT
RANDOM ACCESS MEMORY
IEEE 488 BUS
ADDRESS DECODER
COMBINER BOARD*
MODULE DRIVER BOARDS
DRIVER FOR RF MODULE 1-16 *
DRIVER FOR RF MODULE 17-32 *
DRIVER FOR RF MODULE 33-48 *
DRIVER FOR RF MODULE 49-64 *
DRIVER FOR RF MODULE 65-80 *
DRIVER FOR RF MODULE 81-96 *
MODULES
MODULATION GENERATOR
MODULATION
RF
MATRIX TEST EQUIPMENT INC.
MODEL ASX-16 BLOCK DIAGRAM
REV
DR BY FN
DATE 7-1-84
DWG NO ASX-411-A

FIGURE 1-23

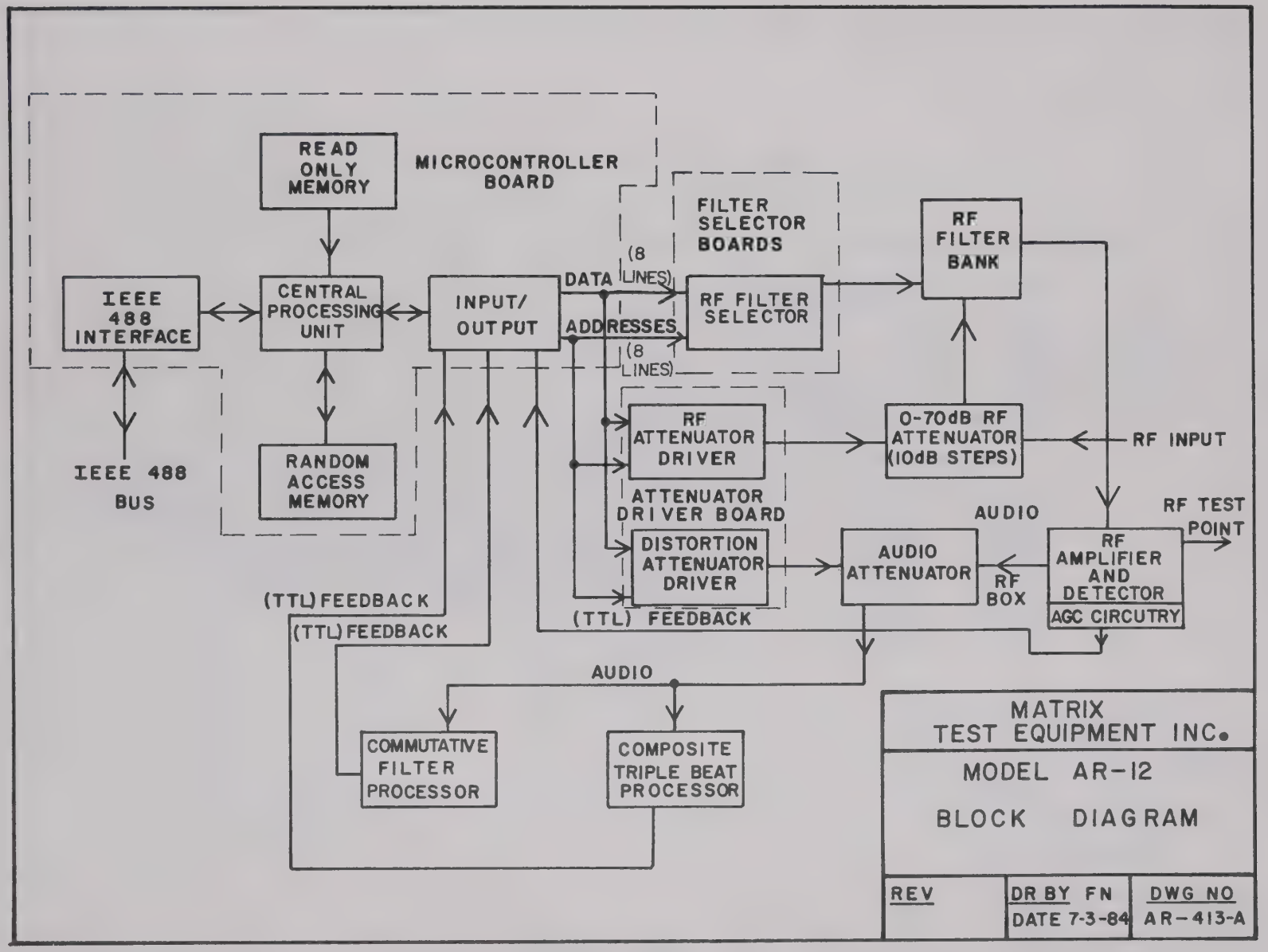

READ ONLY MEMORY
MICROCONTROLLER BOARD
FILTER SELECTOR BOARDS
RF FILTER BANK
IEEE 488 INTERFACE
CENTRAL PROCESSING UNIT
INPUT/ OUTPUT
DATA
(8 LINES)
ADDRESSES
(8 LINES)
RF FILTER SELECTOR
IEEE 488 BUS
RANDOM ACCESS MEMORY
RF ATTENUATOR DRIVER
0-70dB RF ATTENUATOR (10dB STEPS)
RF INPUT
ATTENUATOR DRIVER BOARD
AUDIO
RF TEST POINT
DISTORTION ATTENUATOR DRIVER
AUDIO ATTENUATOR
RF AMPLIFIER AND DETECTOR
RF BOX
AGC CIRCUTRY
(TTL) FEEDBACK
(TTL) FEEDBACK
(TTL) FEEDBACK
AUDIO
COMMUTATIVE FILTER PROCESSOR
COMPOSITE TRIPLE BEAT PROCESSOR
MATRIX
TEST EQUIPMENT INC.
MODEL AR-12
BLOCK DIAGRAM
REV
DR BY FN
DATE 7-3-84
DWG NO
AR-413-A

FIGURE 1-24

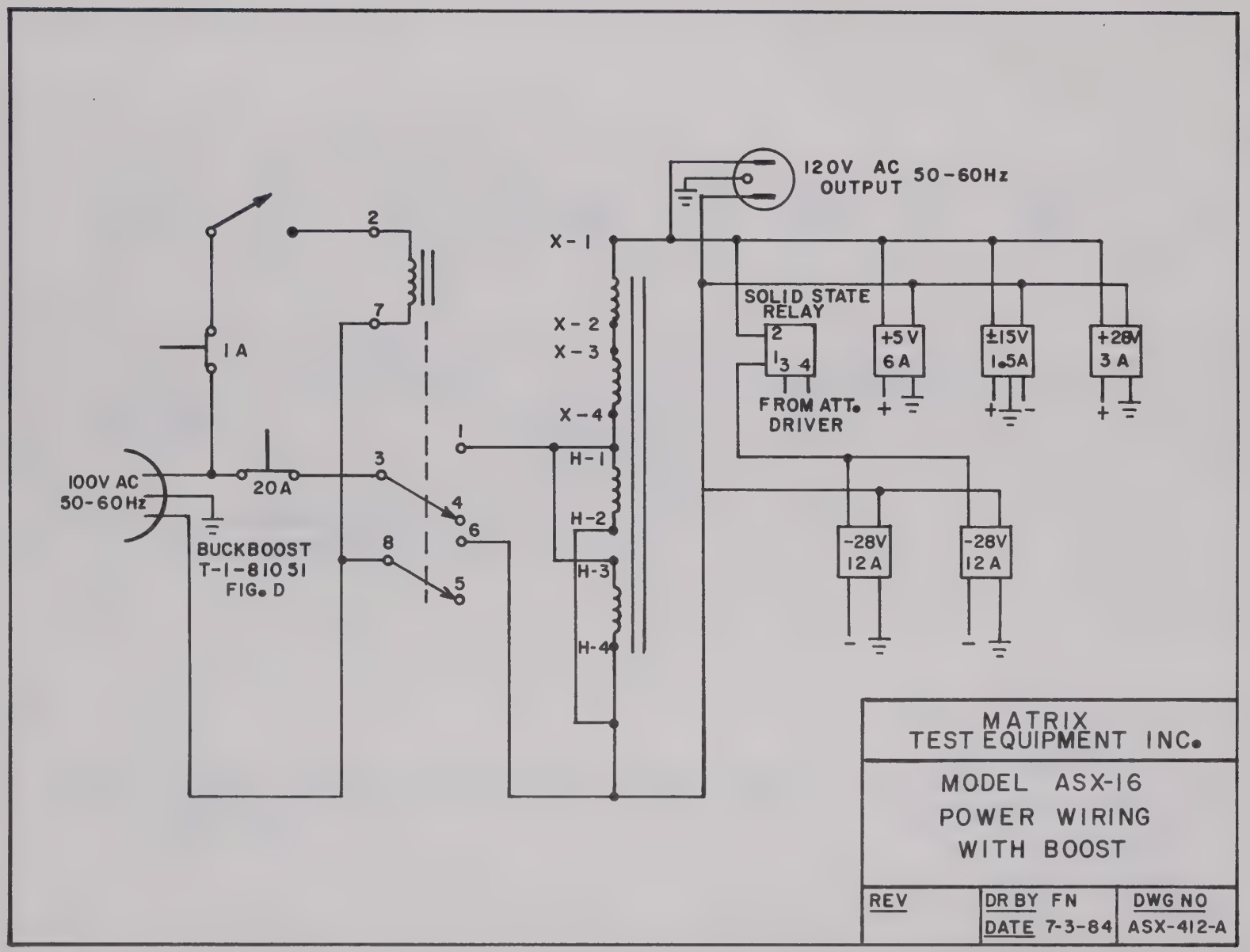
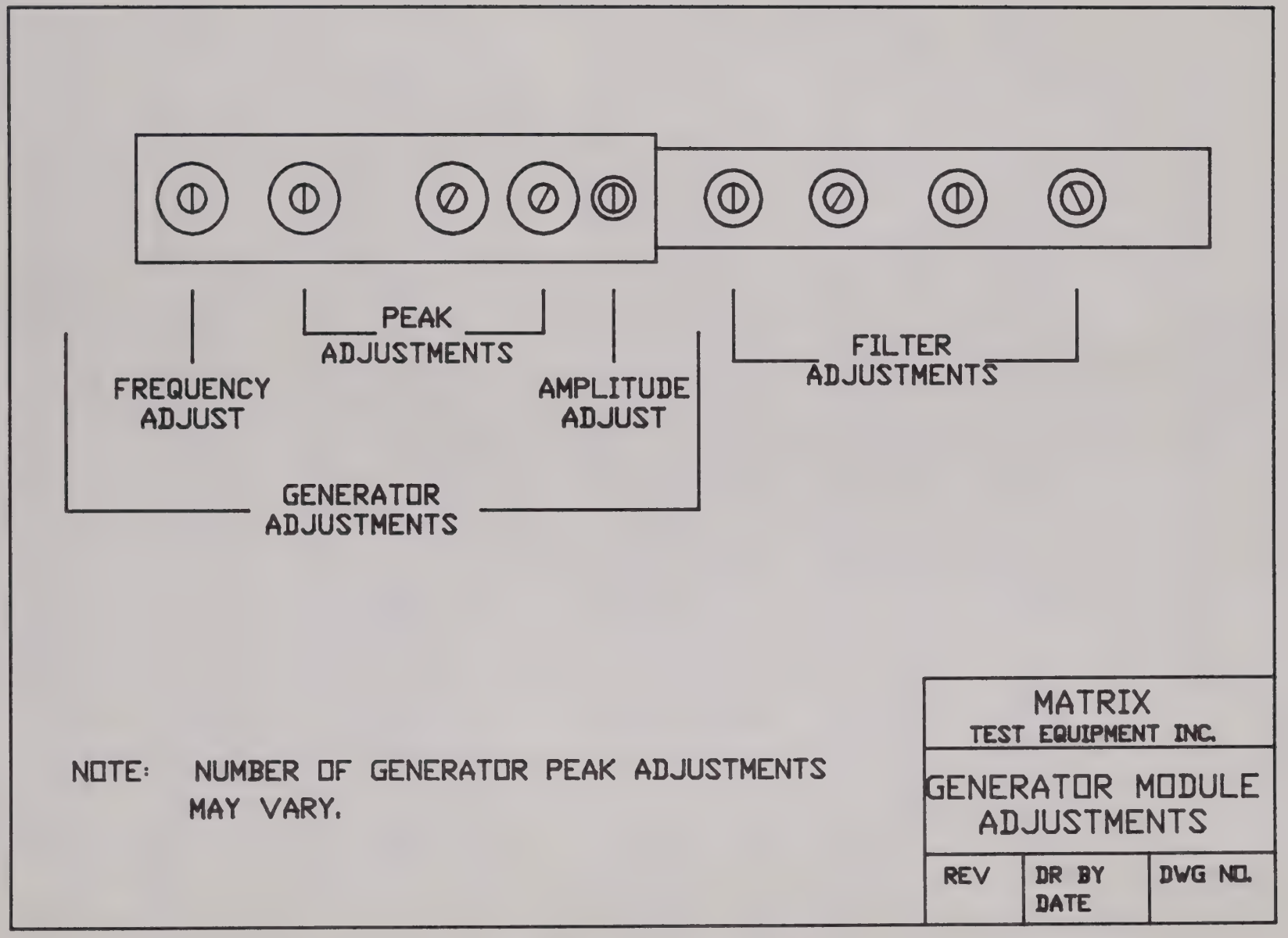

120V AC 50-60Hz
OUTPUT
X-1
X-2
X-3
X-4
H-1
H-2
H-3
H-4
SOLID STATE
RELAY
2
1 3 4
FROM ATT.
DRIVER
+5V
6A
±15V
1.5A
+28V
3A
-28V
12A
-28V
12A
1A
20A
100V AC
50-60Hz
BUCKBOOST
T-1-81051
FIG. D
1
2
3
4
5
6
7
8
MATRIX
TEST EQUIPMENT INC.
MODEL ASX-16
POWER WIRING
WITH BOOST
REV
DR BY FN
DATE 7-3-84
DWG NO
ASX-412-A

FIGURE 1-25



NOTE: NUMBER OF GENERATOR PEAK ADJUSTMENTS MAY VARY.

MATRIX TEST EQUIPMENT INC.		
GENERATOR MODULE ADJUSTMENTS		
REV	DR BY DATE	DWG NO.

FIGURE 1-26

SECTION II

I.E.E.E. STD-488 GPIB OPERATING INFORMATION

2-1. Introduction

The Matrix Test Equipment Inc., Model ASX-16 and Model AR-12 are devices incorporating the normal Model SX-16 and Model R-12 features, but with I.E.E.E. STD-488 Bus Input/Output instead of the conventional manual controls and indicators.

The Model ASX-16 is a multiple frequency signal generator which can be equipped with up to 120 crystal-controlled modules. Each module can be individually turned on and off, modulated with a 15.75 KHz signal, set for CW (no modulation), and output-leveled over a ±5 dB range. Following this bank of modules is an RF attenuator which may be varied over a range of 0 to 81 dB in 1 dB steps.

The Model AR-12 is a signal strength and distortion analyzer which can be equipped with up to 120 receiver filter modules (hereafter referred to as filters) which may be used to select which channel's distortion will be analyzed. The Model AR-12 can be used to measure distortions such as: Cross-Modulation, Discrete Second Order, Discrete Third Order, and Composite Triple Beat. An RF attenuator, which may be varied over a 0 to 70 dB range in 10 dB steps, preceeds the bank of selectable filters.

2-2. Software Interface for the ASX-16

There are two types of commands which are sent to the ASX-16 unit: slave commands and handshake commands. All valid slave commands are executed as soon as the commands are received. Handshake commands may or may not be executed immediately and in either event, will cause the ASX-16 unit to tie-up the bus until a handshake operation has been completed. This will become more clear in the software description below. Data from the ASX-16 is terminated with a Carriage Return signal. The equipment does <u>not</u> issue a Line Feed command.

Note that all signals to the SX-16 unit must contain only UPPER CASE letters. Extra spaces are ignored. Wherever "±" is indicated, it means an <u>unsigned</u> number is assumed positive and a signed number is assumed negative, that is, positive 12 is indicated by "12", negative 12 is indicated by "-12".

Note that when a module number is indicated, the module number should be an integer from 1 to 100. When the module number is 0 (zero) the action is taken on ALL modules (see below). Refer to Table 2-1 for the relationship between module number and channel designations.

Table 2.1. Relationship of Module Number to Channel Designation for Typical 76-Channel Unit.

Module Number	Channel Designation	Module Number	Channel Designation
1	T7	39	T
2	T8	40	U
3	T9	41	V
4	T10	42	W
5	T11	43	X
6	T12	44	Y
7	T13	45	Z
8	2	46	H1
9	3	47	H2
10	4	48	H3
11	5	49	H4
12	6	50	H5
13	A	51	H6
14	B	52	H7
15	C	53	H8
16	D	54	H9
17	E	55	H10
18	F	56	H11
19	G	57	H12
20	H	58	H13
21	I	59	H14
22	7	60	H15
23	8	61	H16
24	9	62	H17
25	10	63	H18
26	11	64	H19
27	12	65	H20
28	13	66	H21
29	J	67	H22
30	K	68	H23
31	L	69	H24
32	M	70	H25
33	N	71	H26
34	O	72	H27
35	P	73	H28
36	Q	74	H29
37	R	75	H30
38	S	76	H31

* * * NOTE * * *

On those Model ASX-16 Generators equipped with the HUM Option, the following command is also available:

SIGNAL	MEANING	TYPE	EXAMPLES
Hmodule	turns "off" all modules except the one specified. The specified module is set for CW (unmodulated) operation. This command is used for setting up the ASX-16 for a Hum distortion test.	slave	H2 H45

SIGNAL	MEANING	TYPE	EXAMPLES
✓Adata	sets the ASX-16's RF Attenuator to the value of the data in dB in 1 dB steps.	slave	A20 A11
✓ AV	requests the ASX-16 RF attenuator's Value. The response from the ASX-16 is a 3-digit number (with leading zeros, if necessary) from 0 to 81. The extra digit allows for the future use of other attenuators which may have values greater than 99 dB.	handshake	AV
✓Cmodule	applies power to the specified module and sets that module for CW (unmodulated) operation.	slave	C18 C60 C28
✓CO	applies power to <u>all</u> modules and sets them for CW (unmodulated) operation. This command is used to set up the ASX-16 modules for a Composite Triple Beat test.	slave	CO
✓Lmodule, ±steps	the indicated module's Level is moved up (no sign) or down (minus sign) by the indicated number of steps. Note: the comma (,) <u>must</u> be sent. Response from the ASX-16 is either N for no-go (cannot move by that number of steps) or G for go (can move by that number of steps).	handshake	L12,15 L12,-15 L3,-127 L3,127
Note:	each module has a 256 step range. On power-up, each module is at step 128, therefore, each may go up a maximum of 127 or down a maximum of 128. Step 255 is maximum power; step 0 is minimum power. When any module is leveled, it is left turned on in the CW mode. This enables a power meter to be used to check the output level.		
LO,±steps	<u>all</u> modules' Levels are altered by moving up (no sign) or down (minus sign) the indicated number of steps. Response from the ASX-16 is same	handshake	LO,15 LO,-15 LO,-127 LO,127

SIGNAL	MEANING	TYPE	EXAMPLES
	as above. If any one of the modules can not be stepped by the amount requested, an N will be sent and no leveling will be performed.		
LMmodule	requests the Level of the specified Module. Response is a 3 digit number (with leading zeros, if necessary) from 0 to 255.	handshake	LM5 LM67 LM42
Mmodule	applies power to the specified module and sets that module to 100% Modulation at 15.75 KHz.	slave	M12 M15 M60
MO	applies power to all modules and sets them to 100% Modulation at 15.75 KHz.	slave	MO
Pmodule	shuts Power "off" on the selected module.	slave	P1 P16
PO	shuts the Power "off" on all modules.	slave	PO
QLOW	sets the Quality factor of the "off" mentioned in the P, S, and T signals. In the QLOW mode, all "off" carriers are unmodulated and 60 dB down from their normal levels. This is the mode the ASX-16 starts in on power-up.	slave	QLOW
QOFF	sets the Quality factor as above, except that all "off" modules have their power removed. In this mode, the oscillators will "cool off", that is, if they are left "off" for a prolonged period of time, they will not be at their "warmed-up" frequencies when power is re-applied.	slave	QOFF
Smodule,module	turns "off" all modules except those specified. The specified two modules are set for CW (unmodulated) operation. This command is used for setting up	slave	S28,37

SIGNAL	MEANING	TYPE	EXAMPLES
	the ASX-16 Unit for a Second Order distortion test. If a synthesizer is used for the third carrier, it is set up separately.		
Tmodule,module,module	turns "off" all modules except those specified. The specified three modules are set for CW (unmodulated) operation. This command is used for setting up the ASX-16 unit for a Third Order distortion test. If a synthesizer is used for the fourth carrier, it is set up separately.	slave	T39,41,42
V±data	Varies the RF attenuator by the amount (in dB) specified by data. The ASX-16 responds with an N for no-go if the attenuator cannot be varied by that amount, and with a G for go if it can. If the attenuator cannot be set for the requested change, no change in the attenuator takes place.	handshake	V12 V-12
Xmodule	turns all modules on in the 100% modulated mode except for the specified module which is set for CW (unmodulated) operation. This is used for making Crossmod (Xmod) tests.	slave	X1 X13 X28

2-3. Software Interface for the AR-12 Unit

Like the ASX-16 unit, the AR-12 unit has two types of commands: slave and handshake. The first three paragraphs in Section 2-2 also apply to the AR-12 unit and will not be repeated here.

There are two methods for making distortion measurements: absolute and within-specifications (within-spec). Using the absolute method, the AR-12 returns a number which corresponds to the actual distortion. This process takes approximately seven seconds per reading if the signal received is within the range

of the AR-12's AGC circuitry. Using the within-spec method, the AR-12 returns a G for go if the distortion is less than or equal to the spec or an N for no-go if the distortion is greater than the spec. This process takes approximately three seconds if the signal received is within the range of the AR-12's AGC circuitry. The within-spec method is also called the go/no-go method.

The AR-12 receiver has an Automatic Gain Control (AGC) circuit which can handle signals over a broad range of input levels. The AGC circuit is further aided by the AR-12's microcontroller which will change the value of the R-12's RF attenuator to bring the input signal level within the capabilities of the AGC circuitry, if possible. For every change of the RF attenuator, the AR-12 pauses approximately one second to allow the AGC circuitry to settle.

If the received signal cannot be brought into AGC range, the AR-12 will transmit an N as the first character in the distortion reading or an N for the go/no-go response. Any data transmitted with an N preceeding it has no practical meaning.

When the AR-12 is first powered-up, the distortion readings it transmits are in error. They contain an offset called the Zero correction factor. Once this factor has been sent to the AR-12, the readings will be correct. The Zero correction factor is subtracted by the AR-12 receiver before it transmits the distortion readings. On power-up the Zero correction factor is zero (0). More information on this is contained below.

The AR-12 readings need to be internally-corrected by the Zero correction factor. When a lone channel is operating with 100% modulation, its distortion should read -0 dB for a Crossmod reading. If a Crossmod (Xmod) reading is made on the AR-12 under this condition on the modulated channel, a non-zero distortion will be read. This, non-zero number is the Zero correction factor for the Second order, Third order, and Xmod. Once the ZSTX command (see below) has been sent to the AR-12, all Second order, Third order, and Xmod readings will be accurate. Note that the within-spec readings will also not be performed correctly until the ZSTX command has been sent.

The Zero correction factor for Composite triple beat readings is a different number than that for the other readings. It is also obtained by having a lone 100% modulated carrier on and by reading the Composite triple beat distortion under these conditions. The non-zero number obtained is the to be sent to the AR-12 using the ZC command. After the ZC command (see below) has been sent, all Composite triple beat readings will be accurate. Note that the Composite triple beat within-spec readings will also not function correctly until the ZC command has been sent.

The Commutative Filter option is intended for distortion measurements made on broad-band devices (devices which pass all carriers that contribute to the distortion). This restriction is due to the requirements of the Receiver's Tone Generator which must detect the audio distortion note (approximately 15.75 KHz) in order for the Commutative Filter to function. Narrow-band devices (such as CATV converters) will not pass enough carriers to create the audio distortion note in the Receiver's Tone Generator. The Commutative Filter option can be used to measure distortions of narrow-band devices if a separate Tone Generator is installed in the Signal Generator and if the output of this Tone Generator is routed to the appropriate input of the Commutative Filter processor.

SIGNAL	MEANING	TYPE	EXAMPLES
Adata	sets the AR-12's RF Attenuator to the value of the data in dB in 10 dB steps over a range of 0 to 70 dB.	slave	A10 A0
AV	identical to the AV command in the ASX-16 portion except a 2 digit number is returned.	handshake	AV
Cfilter	causes a reading to be made of the Composite triple beat distortion using the selected filter. The AR-12 responds with a C, a minus sign, and then the distortion in dB (example: C-56.0) if the AGC loop is locked, otherwise, it replaces the C with an N (example: N-56.0). The "N" indicates the reading is invalid.	handshake	C18 C24
Cfilter,spec	causes a go/no-go Composite triple beat test to be made using the spec number as the deciding point. Note that a positive number is used for the spec, that is, -60 dB is 60 dB down, so the spec is 60. The letter G is transmitted if the reading is within the spec or an N is transmitted if it is not. An "N" will also be sent if the input signal is outside the range of the AGC circuitry.	handshake	C18,56 C23,60
Sfilter	causes a reading to be made of the Second Order distortion. The AR-12 responds as it does for the Composite triple beat test, except that an S is substituted for the C for valid readings (where a valid reading is one made with the AGC loop locked).	handshake	S18 S27

SIGNAL	MEANING	TYPE	EXAMPLES
Hfilter	causes a reading to be made of the HUM distortion. The AR-12 responds as it does for the Composite triple beat test, except an H is substituted for the C for valid readings (where a valid reading is one made with the AGC loop locked). The Zero Correction Factor for the Hum measurement is the same as the one used for Composite triple beat; therefore, it is necessary to utilize the ZC command before making any Composite triple beat or Hum distortion readings. This command will only function on AR-12's equipped with the Hum option.	handshake	H2 H45
PIN	switches in the 20 dB gain Preamplifier. This is used when the input signals are too weak for the AR-12's AGC circuitry to lock on. This command will only function on the AR-12's equipped with the Preamp option.	slave	PIN
POUT	Switches out the 20 dB gain Preamplifier. The Preamplifier should be used only when necessary (for very weak signals). To obtain the best signal-to-noise ratio, avoid using the Preamplifier when it isn't needed. This command will only function on AR-12's equipped with the Preamp option.	slave	POUT

SIGNAL	MEANING	TYPE	EXAMPLE
Sfilter, spec	causes a go/no-go Second order test to be performed (as above for the Composite triple beat).	handshake	S18,85 S25,60
Tfilter	causes a reading to be made of the Third order distortion. The AR-12 responds as above, except that a T is substituted for the C or S for valid readings.	handshake	T20 T48
Tfilter,spec	causes a go/no-go Third order test to be performed (as above).	handshake	T18,60 T25,53
Xfilter	causes a reading to be made of the crossmod (Xmod) distortion. The AR-12 responds as above, except that an X is substituted for the C, S, or T for valid readings.	handshake	X15 X28
Xfilter,spec	causes a go/no-go Xmod test to be performed (as above).	handshake	X16,56 X28,77
ZCdata	gives the AR-12 receiver the Zero correction factor for Composite triple beat readings.	slave	ZC13.5 ZC13.0
ZSTXdata	gives the AR-12 receiver the Zero correction factor for Second and Third order and Xmod readings.	slave	ZSTX3.5 ZSTX4.0

SECTION III

USING THE ASX-16 AND AR-12 WITH A COMPUTER

3-1. Initial Set-up of the Equipment

The following procedure will insure proper operation of the equipment.

1) Make sure the following connections have been made:
   a) power cords to all pieces of equipment;
   b) computer's I.E.E.E. 488 bus connector to ASX-16 and AR-12;
   c) all coaxial connections to and from equipment (as appropriate);
   d) D.C. power to module (or equipment) under test.

2) Apply power to all equipment. Allow five minutes for equipment warm-up if frequency stability is critical for the tests to be performed.

Note that when both the ASX-16 and AR-12 are first turned on, their RF attenuators are automatically set for high values. This protects both themselves and the module or equipment under test from possible damage due to any signals from the RF signal sources that may be hooked up.

3-2. Typical Distortion Tests

The following examples will be written in Hewlett-Packard Basic, compatible with the HP-85 computer. Few modifications, if any, should be necessary to adapt these programs for use with other Hewlett-Packard computers.

As shipped from the factory, the Model ASX-16 is set for I.E.E.E. 488 address "24" and the Model AR-12 is set for I.E.E.E. 488 address "23".

3-2.1. Zeroing the AR-12 Receiver

To find the Zero correction factor for the Commutative Filter Processor (the Processor used for Xmod, Second order, and Third order distortions), use a program similar to the one below. A single ASX-16 carrier is 100 percent modulated, and the AR-12 is told to perform an Xmod reading on that same frequency. In the following two examples, module and filter number 28 have been arbitrarily selected. The Zero correction factors only have to be done once after each time the equipment is first powered up. If it is desired to re-zero the Commutative Filter Processor, at a later time, the command "ZSTX 0.0" should first be sent, to insure the previous Zero correction factor has been removed before the new Zero correction factor is determined.

```
10      REM ASSUME AN AMPLIFIER WITH 30 dB GAIN IS BEING USED
15      REM       BETWEEN THE ASX-16 AND THE AR-12.
20      OUTPUT 724; "PO"
30      OUTPUT 724; "A35"
40      OUTPUT 724; "M28"
50      OUTPUT 723; "X28"
60      ENTER 723 USING "#,A,6*"; R$,D
70      IF R$="N" THEN GOTO 1000
80      OUTPUT 723; "ZSTX"; ABS(D)
90      REM (CONTINUE WITH REMAINDER OF PROGRAM)
1000    PRINT "INSUFFICIENT SIGNAL LEVEL ON MODULE 28"
1010    STOP
```

Line 20, above, turns off all ASX-16 carriers.

Line 30 sets the ASX-16's RF attenuator to 35 dB. This is to prevent overloading of the amplifier.

Line 40 turns on the carrier for module 28 and sets it to 100 percent modulated operation.

Line 50 triggers the AR-12, telling it to perform an Xmod test using filter 28.

Line 60 reads the response from the AR-12 and tells the computer what kind of data it should expect to see. The "#" tells the computer not to wait for a "LINE FEED" character. The "A,6*" tells the computer to read a single alpha-numeric character, followed by a six-character numerical value. The single character is stored as R$; the numerical value is stored as D. A typical response from the AR-12 would look like this:

X-012.5(CR)

where "(CR)" represents the CARRIAGE RETURN character.

Line 70 checks the value of R$. If everything is all right, R$ should be "X", but if there was insufficient signal at the input of the AR-12, R$ will be "N". If there is an error, the program jumps to line 1000.

Line 80 sends the Commutative Filter Processor's Zero correction factor to the AR-12. After line 80 is executed, all Xmod, Second order, and Third order distortion readings will be automatically corrected.

The remainder of the program will follow (lines 90 to 999).

To find the Zero correction factor for the Composite Triple Beat Processor, the above test is repeated, except the Composite Triple Beat Processor is used. Since the ASX-16 has already been set up, we will not have to set it up again. If it is desired to re-zero the Composite Triple Beat Processor, at a later time, the

command "ZC 0.0" should first be sent, to insure the previous Zero correction factor has been removed before the new Zero correction factor is determined.

```
90   OUTPUT 723; "C28"
100  ENTER 723 USING "#,A,6*"; R$,D
110  IF R$="N" THEN GOTO 1000
120  OUTPUT 723; "ZC"; ABS(D)
130  OUTPUT 724; "PØ"
140  REM  (PROGRAM CONTINUES FROM THIS POINT)
```

Line 90 triggers the AR-12, telling it to perform a Composite triple beat test using filter 28.

Line 100 reads the response from the AR-12 and tells the computer what kind of data it should expect to see. The "#" tells the computer not to wait for a "LINE FEED" character. The "A,6*" tells the computer to read a single alpha-numeric character, followed by a six-character numerical value. The single character is stored as R$; the numerical value is stored as D. A typical response from the AR-12 would look like this:

C-024.5(CR)

where "(CR)" represents the CARRIAGE RETURN character.

Line 110 checks the value of R$. If everything is all right, R$ should be "C", but if there was insufficient signal at the input of the AR-12, R$ will be "N". If there is an error, the program jumps to line 1000, as before.

Line 120 sends the Composite Triple Beat Processor's Zero correction factor to the AR-12. After line 120 is executed, all Composite triple beat distortion readings will be automatically corrected.

Line 130 turns off all carriers on the ASX-16, leaving everything in a "safe" condition.

3-2.2. Performing a Cross-modulation Test

A Cross-modulation (Xmod) test is performed by using the special "X" command in both the ASX-16 and the AR-12. Note that the zeroing procedure of Section 3-2.1 should first be performed before any measurements are made. For this example, module and filter number 8 has arbitrarily been selected for the distortion measurement.

```
140   OUTPUT 724; "A35"
150   OUTPUT 724; "X8"
160   OUTPUT 723; "X8"
```

```
170   ENTER 723 USING "#,A,6*"; R$,D
180   IF R$="N" THEN GOTO 1100
190   REM D IS THE DISTORTION READING
1100  PRINT "INSUFFICIENT SIGNAL ON MODULE 8"
1110  STOP
```

The above program is almost identical to those of Section 3-2.1. A typical value of D would be -62.5.

3-2.3. Performing a Composite Triple Beat Test

A Composite triple beat (CTB) test is performed using the special "C" commands in both the ASX-16 and the AR-12. The procedure is identical to that of Section 3-2.2., except the "X8" in line 150 would be replaced by "C0", and the "X8" in line 160 would be replaced by "C8".

3-2.4. Performing a Discrete Second Order Distortion Test

A Second order distortion test is performed by using the special "S" commands in both the ASX-16 and the AR-12. Unless the ASX-16 is equipped with one or more special (offset) carriers, Second order distortion measurements are made using the ASX-16 and an external frequency synthesizer as the carrier sources. In the following example, the Second order distortion will be generated by channels 2, 13 and R (with the measurement being made at channel R). For the distortion to fall exactly at channel R, the channel 2 carrier will have to be offset as given by the following formula:

$$\text{Frequency}_2 = \text{Frequency}_y - \text{Frequency}_{13} + 15.75\ \text{KHz}$$

This frequency will be generated by the external frequency synthesizer. It is advisable to measure the frequencies of channels 13 and R prior to the Second order measurement, in order to determine the exact frequency for the synthesizer.

We will assume channels 2, 13, and R to have module (and filter) numbers 2, 13, and 31, respectively. We will also assume, prior to the execution of line 300, the synthesizer has already been turned on and leveled to the same amplitude as that of the two ASX-16 carriers.

```
300   OUTPUT 724; "A35"
310   OUTPUT 724; "S13,31"
320   OUTPUT 723; "S31"
330   ENTER 723 USING "#,A,6*";R$,D
340   IF R$="N" THEN GOTO 1200
350   REM  (PROGRAM CONTINUES FROM HERE)
1200  PRINT "INSUFFICIENT SIGNAL ON MODULE 31"
1210  STOP
```

Line 310 sets up the ASX-16 for a Second order test. Channels 13 and R are set for CW operation; all other ASX-16 carriers are turned off.

The remainder of the program is virtually identical to those already discussed.

3-2.5. Performing a Discrete Third Order Distortion Test

A Third order distortion test is performed by using the special "T" commands in both the ASX-16 and the AR-12. Unless the ASX-16 is equipped with one or more special (offset) carriers, Third order distortion measurements are made using the ASX-16 and an external frequency synthesizer as the carrier sources. In the following example, the Third order distortion will be generated by channels S, T, V, and W (with the measurement being made at channel V). For the distortion to fall exactly at channel V, the channel S carrier will have to be offset as given by the following formula:

$$Frequency_S = Frequency_V + Frequency_t - Frequency_W + 15.75\ KHz$$

This frequency will be generated by the external frequency synthesizer. It is advisable to measure the frequencies of channels V, T, and W prior to the Third order measurement, in order to determine the exact frequency for the synthesizer.

We will assume channels T, V, and W to have module (and filter) numbers 33, 35, and 36, respectively. We will also assume, prior to the execution of line 400, the synthesizer was already turned on and leveled to the same amplitude as that of the ASX-16 carriers.

```
400   OUTPUT 724; "A35"
410   OUTPUT 724; "T33,35,36"
420   OUTPUT 723; "T35"
430   ENTER 723 USING "#,A,6*";R$,D
440   IF R$="N" THEN GOTO 1300
450   REM  (PROGRAM CONTINUES FROM HERE)
1300  PRINT "INSUFFICIENT SIGNAL ON MODULE 35"
1310  STOP
```

The above program is virtually identical to that of Section 3-2.4.

3-2.6. Adjusting the Output Levels of the ASX-16

When leveling the ASX-16's output, the RF attenuators are used to bring the carrier levels within 1 dB of the desired level using the ASX-16's "A" or "V" commands. This is done after

measuring the amplitude of a carrier in the center of the channels to be used. The final "fine-tuning" of the carrier amplitudes is performed using the ASX-16's "L" command. This allows the individual modules to be sloped and precisely adjusted as required by the particular application.

To perform the leveling, an external power meter (or similar device) must be used. In order to cover all possible equipment, a flow chart, rather than a program, will be given. The flow chart assumes the following instructions are contained in the program:

```
400   OUTPUT 724 "PØ"
500   OUTPUT 724; "C"; M
600   OUTPUT 724; "L" ; M; ","; A
601   ENTER 724 USING "#,A"; R$
602   IF R$="N" THEN GOTO 2000
2000  PRINT "ERROR"
2010  PRINT "MODULE NUMBER "; M; " IS AT ITS LIMIT"
2020  STOP
```

Line 400 turns off all ASX-16 carriers.

Line 500 turns on a selected module (module number "M") to its CW mode.

Line 600 levels module number "M" by A steps. If A=10, module number "M" is set higher by 10 steps. If A=-13, module number "M' is set lower by 13 steps.

Line 601 completes the "handshake" operation.

Line 602 tests to be sure the leveling was properly completed and that the module did not run out of its leveling range.

3-2.7. Performing Tests Without Using All Carriers

It is often desirable to make distortion measurements using a limited number of carriers. For example, the ASX-16 might be outfitted with seventy-six channels, but the desired Xmod test is to be performed using only channels 2 through W. The carriers below 2 (module numbers 1 through 7, in this example) and those above W (modules 43 through 76) must be turned off. This can be performed using the following modification to the program of Section 3-2.2.

```
140   OUTPUT 724; "A35"
150   OUTPUT 724; "X8"
151   FOR I=1 TO 7
152   OUTPUT 724; "P"; I
153   NEXT I
154   FOR I=43 TO 76
```

```
155   OUTPUT 724; "P"; I
156   NEXT I
160   OUTPUT 723; "X8"
170   ENTER 723 USING "#,A,6*"; R$,D
      (ETC.)
        "
        "
        "
```

Lines 151 through 153 and lines 154 through 156 turn off two groups of undesired carriers.

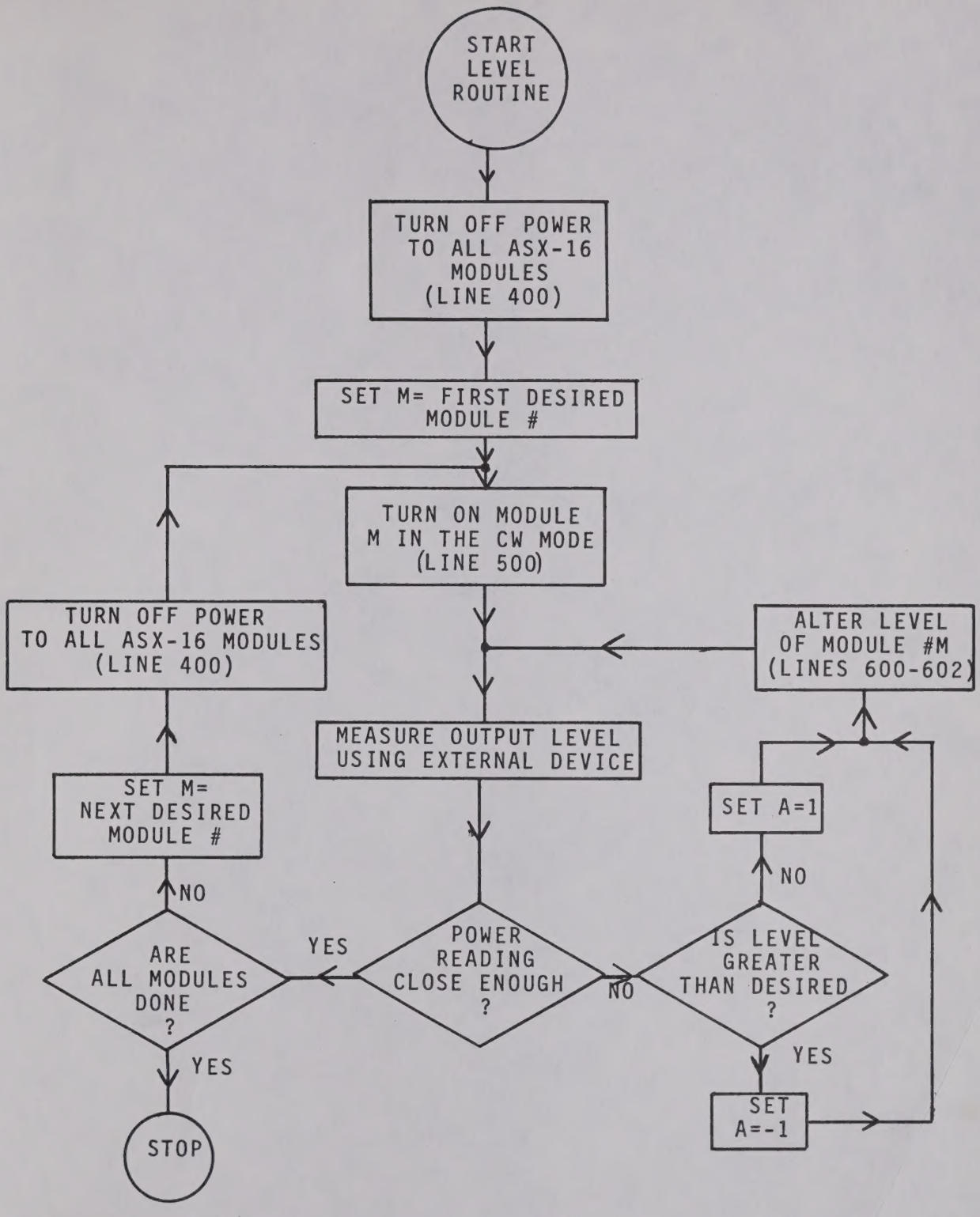

START LEVEL ROUTINE
TURN OFF POWER TO ALL ASX-16 MODULES (LINE 400)
SET M= FIRST DESIRED MODULE #
TURN ON MODULE M IN THE CW MODE (LINE 500)
ALTER LEVEL OF MODULE #M (LINES 600-602)
MEASURE OUTPUT LEVEL USING EXTERNAL DEVICE
POWER READING CLOSE ENOUGH ?
YES
NO
IS LEVEL GREATER THAN DESIRED ?
NO
SET A=1
YES
SET A=-1
ARE ALL MODULES DONE ?
NO
SET M= NEXT DESIRED MODULE #
TURN OFF POWER TO ALL ASX-16 MODULES (LINE 400)
YES
STOP

Figure 3-1. Leveling Flow Chart for ASX-16.

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